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1973 MELFORT FORAGE PROJECT PROGRESS REPORT

M. Feldman

W. Coates

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1973 MELFORT FORAGE PROJECT PROGRESS REPORT

M. Feldman
Engineering Research Station
Agriculture Canada, Ottawa

W. Coates
Agriculture Canada Research
Station, Melfort, Sask.

INTRODUCTION

This project at the Canada Agriculture Research Station, at Melfort, with Engineering input from ERS, and machinery made available by Industry, had been underway since 1970. The continuing importance of forage, and the willingness of the parties involved to keep supporting this work, should ensure further work in this area in the next few years. An Engineer has now joined the Melfort staff, so more of the Engineering responsibility will be assumed by the Research Station.

In conjunction with this work, Engineering Research Service is developing systems analysis to determine research needs, and utilize information gained with regard to forage systems.

Progress reports have been written each year as a preliminary documentation of the work done and the results available for the use of the project participants. This report describes the tests performed in 1973, and the results available so far. Due to widespread interest in the project, the progress for this year has been issued as an Engineering Report to provide up-to-date information.

As data and results are finalized, more formal publications are made. The relevant papers prepared since the last progress report are as follows:

(1) Feldman, M. and Beacom, S.E. - CSAE paper 73-310
Effect of Harvesting Equipment and Bale Management Methods on Hay Quantity and Quality.

(2) Feldman, M. and Lievers, K.W. - CSAE paper 73-308
Effect of Cutting Method, and Conditioning, on Field Drying Rates of Hay in Saskatchewan.

(3) Jackson, H.A., Feldman, M. and Beacom S.E. - CSAE paper 73-501
Progress in the Development of a Hay Tower for Drying, Storing and Mechanically Handling Chopped Hay.

(4) Jackson, H.A. and Robertson, J.A. - CSAE paper 73-215.
Comparison of Packed and Non-Packed Storage of Silage in Horizontal Silos in a Cold Climate.

HAYTOWER

The haytower was erected at the Melfort Research Station in the summer of 1971 in an attempt to evaluate its ability to handle, store and artificially dry chopped hay. During the first two fillings, in 1971 and 1972, the tower developed a lean due to uneven settling caused by a design problem and it was not until this past summer that the tower was first filled to capacity. The lean was prevented this year by the addition of a blind duct extending through the tower opposite to the air duct, resulting in more even settling of the hay.

An additional problem resulted from the hay bulging outward as it settled. Bulging was extensive enough to contact the columns, pushing them outwards and thereby deforming the roof. Whether this deformation is permanent or not won't be known until the tower is unloaded during this feeding season. Because of the expanded diameter of the settled hay, the roof cannot be lowered down over the hay for unloading. As a result, it is necessary for a man to fork the hay away from around the top of the stack allowing the roof to be lowered far enough for the unloading augers to contact the hay.

One possible reason for the bulging problem could be the length of cut. In previous years a theoretical length of cut of 1 1/2 inches was used; however this summer the forage harvester limited the length of cut to 1 1/8 inches. Either of these lengths, when compared to the 4-inch length of cut used in Europe, is much shorter and could easily add to the bulging problem as binding of the stack would be poorer.

Another problem developed during the drying operation in 1973, with a new bung tried for the first time. Rather than being a three-section telescoping unit it consisted of a metal top section and canvas bottom. During the drying operation the hay settled down around the bung exposing about 1/2 of the canvas portion. The drying air being forced by the canvas initiated a flapping action in the skirt and caused a cavity to form around the bung. This allowed the air to escape rather than being forced through the hay. Whether this happened late enough in the drying operation, not to have caused any major harm won't be known until the tower is completely unloaded this spring. The temperatures recorded this summer however, do not indicate any trouble.

Table I lists the data collected while filling the tower in 1973. To date, the hay unloaded from the tower has again been of excellent quality. However, average dry matters have been in the range of 91 to 92% , indicating a serious overdrying problem.

Table I - 1973 Haytower Harvest Data

Weight Stored	122.9 wet tons
	80.9 dry matter tons
Crops Stored	Brome - Alfalfa, Crested Wheatgrass, Brome
Dry matter range at filling	50 - 80%
Average dry matter	65.8%
Gallons of fuel used	1220
Total Blower Time	670 hrs.
Time Without heat	430 hrs.

SYSTEMS TEST

The systems test was initiated in 1972 to directly compare the quantity and quality of one crop harvested and stored in four different ways. The crop chosen for this test has been alfalfa-brome handled in the following four ways:

1. silage - harvested at 65% moisture content
2. artificially dried chopped hay - harvested at 40% moisture content
3. mechanically stacked loose hay - harvested at 30% moisture content
4. baled hay - harvested at 20% moisture content.

The silage was stored in a 20' x 40' bunker silo, sealed with polyethylene plastic and insulated with bales. The chopped hay was harvested with the same forage harvester as the silage, but was blown into the haytower for drying and storage. The long hay was formed into stacks by the McKee stacker and then stored outdoors while the baled hay was hauled directly to sheltered storage from the baler.

Table II lists the results of the quality evaluation of the 1972 forage as determined by feeding trials using four pens of 18 steers each. The harvest data for 1973 is presented in Tables III to V.

Table II - 1972 Systems Test - Feeding Trials

Harvest Method	Feed efficiency (lbs d.m./lb gain)	Animal Gain (lbs/day)	Intake (lbs. d.m./day)
Silage	8.5	1.41	12.0
Haytower	7.7	1.76	13.6
Stacks	8.7	1.60	13.9
Bales	8.0	1.59	12.8

Table III - 1973 Systems Test Field Sizes and Yields

Field (or Replication)	Field Size (acres)	Yield (lbs d.m./acre)
1	8.44	4376
2	8.36	4436
3	12.87	4600
4	9.37	6186
5	7.04	5288

Table IV - 1973 Systems Test Moisture Contents at Harvest

Harvest Procedure	Moisture Content (%)					Weighted
	Rep I	Rep II	Rep III	Rep IV	Rep V	Average
Silage	66.0	62.3	64.9	66.1	58.2	64.9
Haytower	46.0	47.4	32.2	33.4	30.5	37.5
Stacks	28.7	26.8	22.3	28.1	25.5	26.0
Bales	18.8	13.9	15.9	11.6	12.9	14.4

Table V - 1973 Systems Test Amounts Harvested

Harvest Procedure	Weights harvested (lbs dry matter/acre)					
	Rep I	Rep II	Rep III	Rep IV	Rep V	Average*
Silage	4995	4799	4875	6583	7319	5714[a]
Haytower	4603	4582	4728	5671	6577	5236[ab]
Stacks	4696	5007	4853	5306	6426	5257[ab]
Bales	4345	4314	5274	5327	6202	5092 [b]

* Note: Weights marked by the same superscript are not statistically different.

The 1973 systems test involves a feeding trial that utilizes 4 pens of 21 heifers each. Each pen of heifers will be on each forage system for a period of 6 weeks preceeded by a one week buffer period. Table VI shows the results for only the first 6 weeks feeding period.

Table VI - 1973 System Test - Feeding Trial For 6 Weeks Only

Treatment	Animal Gain (lbs/day)
Silage	1.15
Haytower	1.32
Stacks	0.63
Bales	1.14

SILAGE

During the first three years of this test, the objective was to determine the relative nutritive value and losses due to freezing and spoilage in bunker silos with and without packing the silage. In addition, during the final year of this test program, an acid preservative was applied to half of the silage in an attempt to determine its effect.

In 1973, the packing tests were discontinued and were replaced by a test to compare wilted to non-wilted silage. Again half of the silage was treated with an acid preservative. Unlike previous years when sweet clover or alfalfa-brome was used as the test crop, oats was ensiled this year. As in last year's tests, the silos were covered with plastic and insulated with bales. Again this summer temperatures were recorded for a period of time following ensiling. The temperatures were recorded twice daily 8:30 A.M. and 8:30 P.M. then averaged. Two thermocouples per silo were used. There were located midway through the depth of the silos and approximately 1/3 of the distance in from each end.

A complete summary of the results of the feeding trials and losses incurred during the first three years when packed and unpacked silage was compared, is shown in Table VII.

The results show less dry matter loss in the packed silo except when there was cold weather during the feeding period and then only if no protection (insulated with bales) was provided. Feeding trial results indicated better feed efficiency and weight gain with the packed silage. The feeding trial and material loss results for the formic-acid treated silage were too variable to indicate any advantage or disadvantage.

TABLE VII - PACKED VERSUS UNPACKED SILAGE IN HORIZONTAL SILOS

	1970		1971				1972			
	SC		SC		BA		SCT		SC	
Silage:	P	UP	P	UP	P	UP	P	UP	P	UP
Weight stored (tons dm)	34.6	32.9	15.9	15.4	16.6	15.9	18.7	19.9	19.3	19.3
% losses	20	20	34	20	35	26	13	25	6	29
Density (lb dm/cu ft)	13.3	8.7	14.9	10.9	13.3	10.7	14.2	11.4	14.2	11.4
Avg. dry matter content (%)	27	27	36	36	49	45	30	32	31	32
Feeding Trials:										
Avg. initial animal weight (lb)										
no grain	533	528	618	613	614	616	601	600	598	601
grain	529	536	617	618	614	613	603	599	600	600
Avg. daily dm intake (lb)										
no grain	9.8	9.4	10.8	12.5	14.0	13.2	17.2	16.5	16.6	13.6
grain	9.4	9.5	14.6	12.9	13.8	14.7	14.4	16.5	15.5	15.3
Avg. daily gain (lb)										
no grain	0.76	0.34	1.11	0.88	1.39	1.24	1.82	1.41	1.96	1.33
grain	1.68	1.54	1.73	1.44	1.96	1.60	2.33	2.17	2.03	1.86
Feed efficiency (lb dm/lb gain)										
no grain	12.9	27.7	9.8	14.3	10.1	10.7	9.4	11.7	8.4	10.2
grain	7.7	8.4	8.4	8.9	7.0	9.2	6.2	7.6	7.6	8.2

BA - Brome-alfalfa
SC - Sweetclover
SCT - Sweetclover, treated
P - packed
UP - unpacked
dm - dry matter

Table VIII - 1973 Silage Test - Harvest Data

Treatment	Tons (wet)	Moisture Content (%)	Tons (dry)	Max. Temp. (°F)
Not Wilted	57.3	65.0	16.2	94.5
Not Wilted (Acid)	57.8	64.9	16.4	91.5
Wilted	46.8	53.7	17.0	98.0
Wilted (Acid)	53.3	54.2	20.3	88.5

Figure 1 shows the temperatures recorded in 1973 in each of the four silos. The graph shows that the acid treated silos exhibit the lowest temperatures throughout while the wilted silage without acid has the highest temperatures of all the treatments. This indicates that acid does have some effect on reducing the temperatures while wilted silage will heat more than straight cut due to the lower moisture content.

Further results of this test won't be known until the end of the feeding trials this winter.

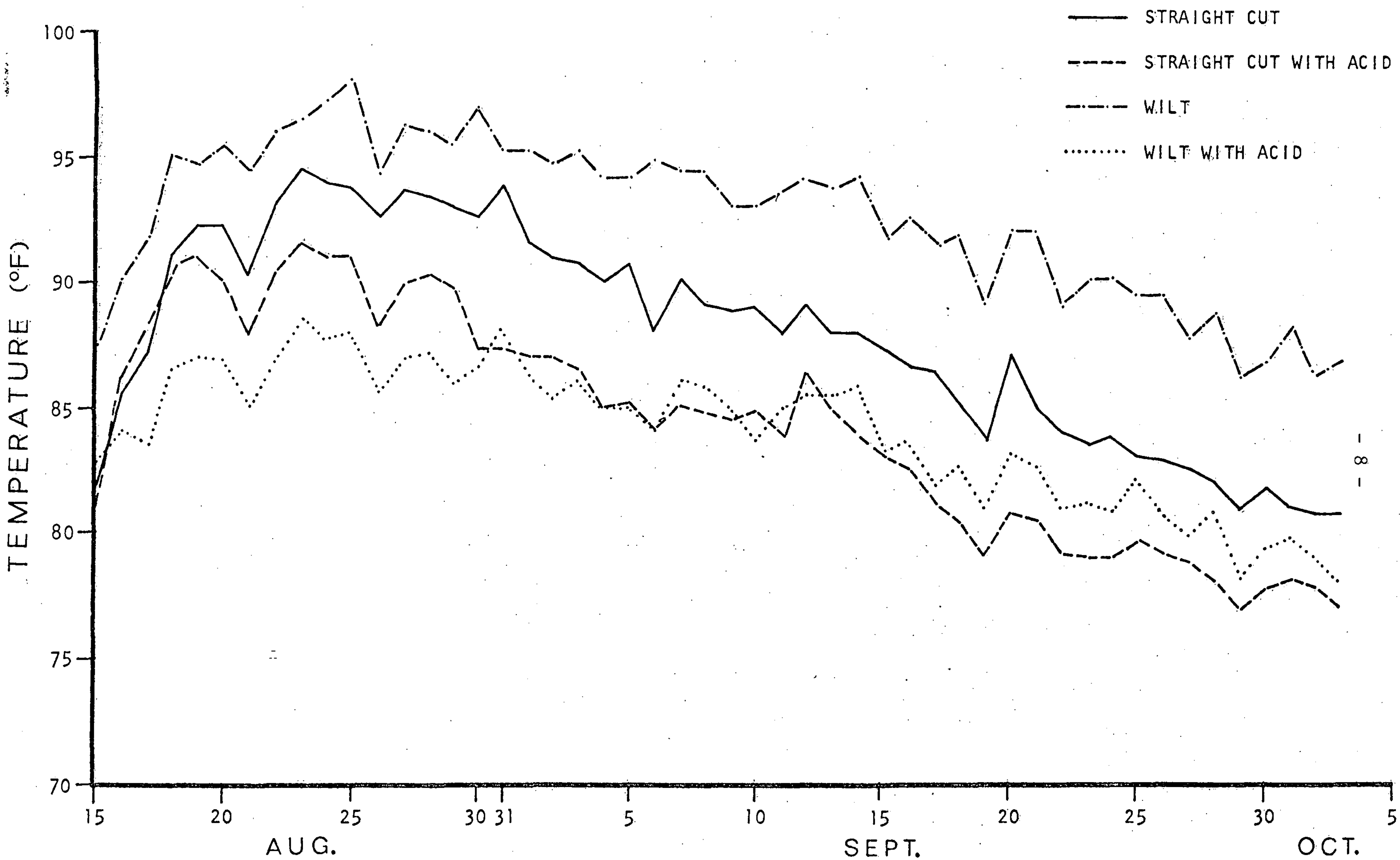

Figure 1 - Silo temperatures - Oats silage - Melfort, 1973.

LONG LOOSE VS. BALED HAY TEST

The preliminary work for this test began in 1971 when a few stacks of loose hay were made mechanically using a Hesston 30 Stacker. In 1972 stacks made by two types of mechanical stackers, the Hesston 30 and the McKee 1000, were compared to rectangular bales which were stooked and allowed to weather in the field for a few weeks. In addition to comparing the three packaging procedures, three crop types, (crested wheatgrass, intermediate wheatgrass and brome) were looked at along with two levels of moisture content at harvest.

During the 1973 summer, the same three crops and two moisture contents were used along with three packaging procedures (Table X). However, rather than using two stacking wagons, only the Hesston 10 was used while a Vermeer giant baler replaced the McKee wagon. The third system was again that of rectangular bales.

The feeding trials for the 1972 crop year were conducted in the summer of 1973 using lambs which were born the previous spring. The results of these trials are tabulated in Table IX.

Tables IX - 1972 Stacks and Bales Feeding Trials

Hay Type	Harvest Method	% Moisture At Harvest	% Moisture At Feeding	Dry Matter Digestibility (%)	Intake (d.m./day lbs)
Crested Wheatgrass	Hesston	35	17.4	59.5	1.58
	McKee	35	19.4	56.9	1.55
	Bale & Stook	34	11.8	60.4	1.84
	Hesston	29	14.9	56.4	1.48
	McKee	29	20.2	57.3	1.58
	Bale & Stook	19	9.1	58.7	1.39
Intermediate Wheatgrass	Hesston	38	17.4	59.2	1.51
	McKee	38	21.8	59.3	1.40
	Bale & Stook	27	12.3	57.5	1.32
	Hesston	27	17.7	58.0	1.34
	McKee	27	23.3	56.2	1.37
	Bale & Stook	22	13.0	59.4	1.51
Brome	Hesston	41	17.0	51.7	1.20
	McKee	41	20.2	51.6	1.39
	Bale & Stook	30	11.9	57.0	1.78
	Hesston	31	15.2	54.2	1.48
	McKee	31	29.0	52.0	1.57
	Bale & Stook	20	13.5	58.1	1.49

Table X - 1973 Stacks and Bales Harvest Data

Crop	Machine	Moisture Content (%)	Amount Harvested (lbs. d.m./acre)	
Crested Wheatgrass	Hesston	24.3 11.3	5180 4472	
	Vermeer	28.2 13.3	5218 4482	
	Bales	23.4 13.2	6383 4186	
Intermediate Wheatgrass	Hesston	25.5 23.4	2982 2903	
	Vermeer	24.0 16.0	2282 2670	
	Bales	23.8 16.5	2941 2928	
Brome	Hesston	23.9 18.2	3593 3533	
	Vermeer	23.5 21.2	3783 3837	
	Bales	23.6 21.2	3850 3438	
Mean	Hesston	24.9 17.9	3918 3636	3777
	Vermeer	25.3 17.4	3761 3663	3712
	Bales	23.6 17.4	4391 3517	3954
	All machines	High m.c. Low m.c.	4024 3605	

Statistical analysis of the 1973 data in Table X indicates that a difference in the amount harvested material (inverse of field losses) could be detected due to level of moisture content at harvest. In addition differences in the amount harvested per acre due to crop type were also detected but no statistically significant differences between machine treatments in amounts harvested were found.

FIELD DRYING RATE TESTS

In 1973, measurements of field drying rates of swaths and windrows produced by different harvesting machines were continued. Higher crop yields and wider machines than during the previous 3 years were involved. The six treatments required use of the mower (7 ft.), mower-conditioner combination in both swath and windrow modes (12 ft.), rotary-drum mower (9 ft.), and self-propelled windrower (16 ft.). The latter machine was tested with and without the crusher attachment.

Weather during the test was varied, with the first of the two replicates receiving excessive rainfall. Both replicates experienced at least one rewetting cycle. The test provided a variety of weather data to examine correlating weather parameters with drying rates.

Detailed analysis is underway, but a preliminary statistical analysis of the first replicate showed that the samples for mow-condition, swath mode, were consistently drier than the average at each time point. Samples from the SP windrower (without conditioner) were consistently wetter than average. The mow-conditioner treatment (windrow mode) started wetter and ended up drier than average. The conventional mower treatment seemed to start drier and end up wetter than average. Samples taken from the windrow treatments had more variation than did those from the swath treatments.

As confirmation of work done in previous years, the mower-conditioner (swath mode) produced the fastest drying and quickest rewetting. Following heavy rains, this treatment did not dry any faster than other treatments.

Over the four years of the test, the relationship between the slowest drying and the fastest drying treatments remained approximately the same with an advantage of roughly one day earlier baling for the faster treatments. Contrary to expectations based on previous work, the use of the crusher attachment for the windrower seemed to have an effect on the drying rate following a rewetting cycle. In 1973, the 12-ft. mower-conditioner windrow appeared to have no appreciable drying advantage over the 16-ft. SP windrower with crusher. In 1972, the 9-ft. mower-conditioner windrow had a slight advantage over the 16-ft. SP windrower with crimper. In 1973, the raking or turning operation had a marked effect on the windrow drying rate. The heavier yield was a probable factor.

Table XI - Crops used for drying rate tests

Year	Alfalfa-Brome (tons DM/acre)	Sweet Clover (tons DM/acre)
1970	1 3/4 - 2 1/4	-
1971	3/4 - 1 1/4	1 - 1 1/2
1972	1 1/2 - 2	-
1973	2 1/2 - 3	-

Table XII - Cutting widths (ft) for drying rate tests

Treatment	1970	1971	1972	1973
Conventional mower	7	7	7	7
Rotary drum mower			5	9
Mower-conditioner (swath)	9	9	9	12
Mower-conditioner (windrow)	9	9	9	12
SP windrower (crusher)	10		10	16
SP windrower (crimper)		10	10	
SP windrower (crimper)			16	
SP windrower (no conditioner)				16

MECHANICAL STACKER TEST
(Supplementary to long loose hay vs. baled hay tests)

In 1972 eight stacks were put up using McKee and Hesston stacking wagons. Three crops, crested wheatgrass, intermediate wheatgrass and brome were used in the test and an acid preservative was applied to some of the stacks.

In 1973 the same test continued. However, an attempt to vary moisture content at stacking time was also incorporated into the program.

For the feeding trials with 1972 stacks only Hesston stacks were used with some having been treated with a preservative and others not. Of the Hesston stacks thatwere fed all had mouldy and musty centers, and the brome stacks were so bad that they were not fed at all. Table XIII lists the results that were obtained in the feeding trail utilizing two groups of 16 ewes per treatment.

Table XIII - The 1972 Feeding Trials with Hesston Stacks - Stacker Test

Crop	% Moisture Content		Acid Applied	Intake
	At Harvest	At Feeding	(lbs/wet ton)	(lbs d.m./day)
Crested	33	20	13	5.09
Wheatgrass	34	16	0	4.52
Brome	44		12	Not Fed
	42		0	Not Fed
Intermediate	36	18	19	3.70
Wheatgrass	34	19	0	3.84

In 1973, a total of 14 stacks were put up in this test. Of these stacks 10 were Hesstons and 4 were McKee. None of the McKee stacks were treated with acid, however half of the Hesston stacks were. A list of the intermediate wheatgrass stacks put up with the Hesston stacker follow (Table XIV), along with the moisture content of the stacks at harvest and the amount of acid applied to each.

Table XIV - 1973 Harvest Data for Hesston Stacks

Wet Weight (lbs)	Moisture Content (%)	Dry Weight (lbs)	Acid (lbs/wet ton)
3000	40	1800	9.8
2760	40	1656	
3020	35	1963	17.2
3060	35	1989	
2680	30	1876	13.8
2660	30	1862	

Table XV - 1973 Stacker Test - Harvest Data

Crop	Hesston (lbs d.m./acre)	McKee (lbs d.m./acre)
Crested Wheatgrass	5322	4914
Intermediate Wheatgrass	4412	
Brome	5092	5122
Mean	4730	5018

Statistical analysis of the amounts harvested per acre (Table XV) showed no significant difference in crop losses between machines.

Figures 2 and 3 show cross sections from one single McKee stack. These drawings show the frozen and semi-frozen areas. The frozen areas were essentially solid ice, having a moisture content in order of 80% and had spoiled prior to freezing as exhibited by a dark brown color.

In looking at the Hesston stacks no evidence of internal freezing has been found, however a one-inch surface crust does exist. All of the McKee stacks which were probed with a rod were found to have frozen material within them and lying at depths from 6 to 24 inches.

The differences noted above are due basically to the differences in stacks shapes. As the Hesston unit is a compaction type stacker, operator skill is not quite as critical and as a result somewhat better shaped stacks were formed by our operators. As a result these tended to shed the weather better and hence no frozen sections were found. On the other hand, the McKee stacks settled a fair amount and did so unevenly leaving the tops rough and full of pockets and allowed rain to soak into the stack. When the weather turned cold the areas froze leaving the patterns shown.

Further data on the overall quality of the stacks won't be known until laboratory tests are conducted on core samples and until the feeding trials have been conducted this winter.

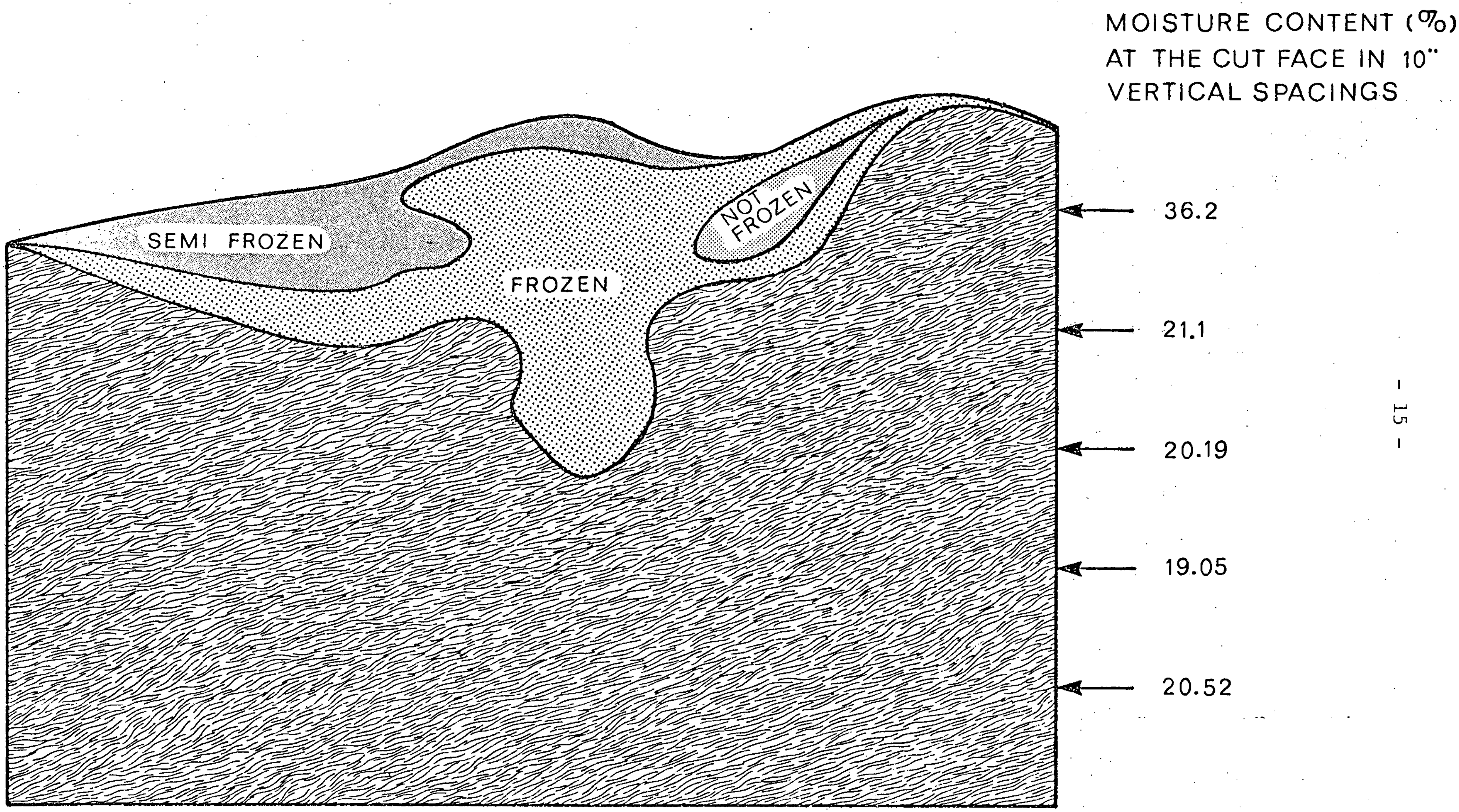

Figure 2 - McKee stack cross-section at 1/3 of its length (sampled just after feeding began); brome-alfalfa, 1973 systems test.

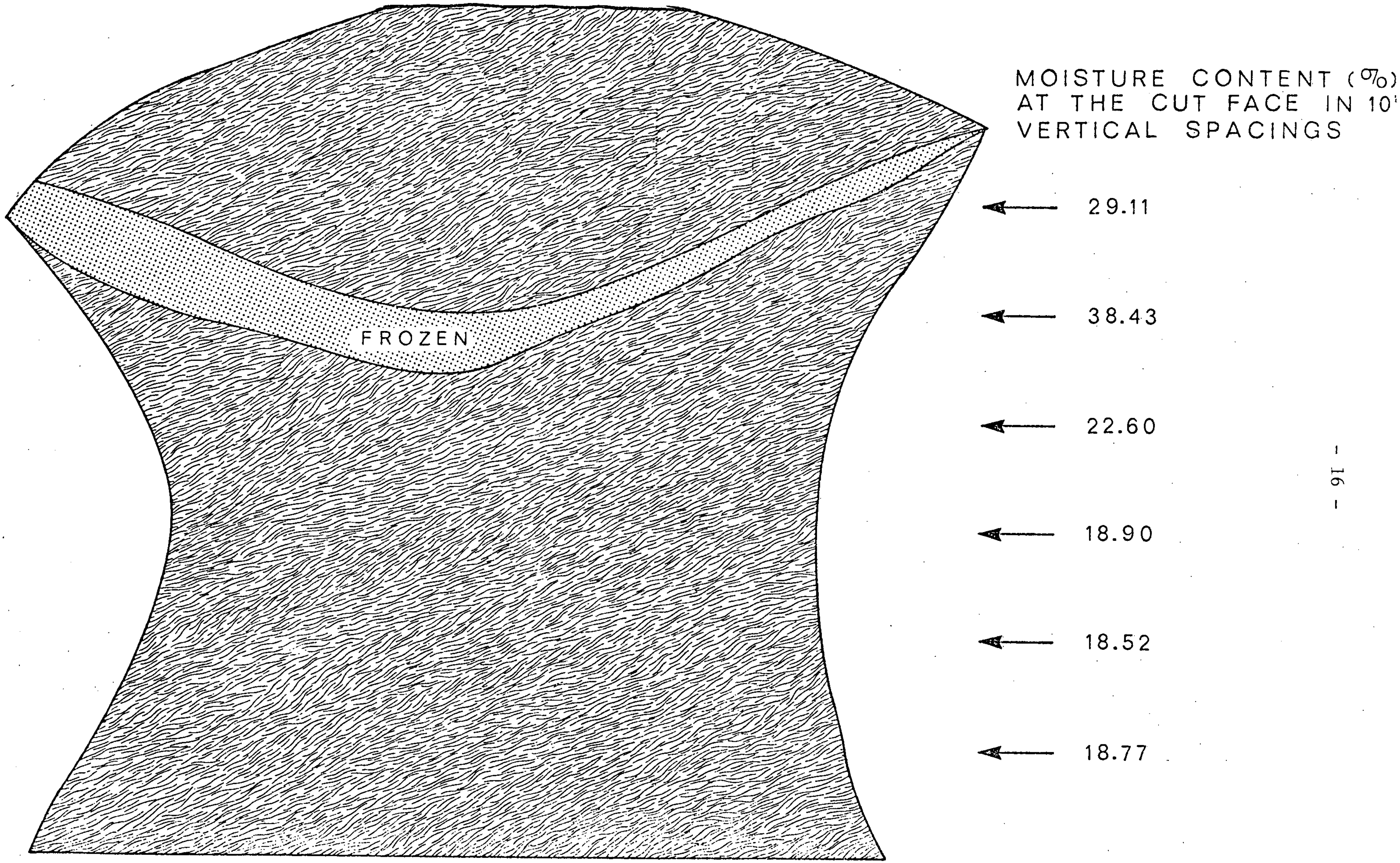

Figure 3 - McKee stack cross-section at 2/3 of its length (sampled after one weeks feeding); brome-alfalfa, 1973 systems test.