THE CRUSHER

Effect of Harvest Technique on Alfalfa Drying Time

Ivan J. Cook[1]

BACKGROUND

I'm here to share with you some exciting things that have developed in the past year in alfalfa harvesting. Like you, I experienced hay damage due to rain, especially during the first and last cuttings. What should have been good dairy hay became feeder quality or less.

About four years ago I started thinking of developing something to reduce drying time. I reasoned that if the standard conditioning rolls improved drying time because of adding crimps to the stem every three to four inches, the hay would dry even faster if there were more places where the stem moisture could escape. In the process, I established my goals and developed the criteria of what and how it had to happen.

GOALS:

1 To crush the full length of the stem rather than just adding more crimping across the stem. I wanted the material to lay out like a ribbon and as thin as a piece of paper.

2. There must be good feedability through the rolls and not plug any more than in conventional machines.

3 The rolls had to be strong and durable.

4. The material on the rolls had to withstand the extreme pressure required to achieve the desired compression.

5 There could not be any increased leaf loss as a result of using the crusher.

6. The entire piece of equipment must be quality built, durable and easy to maintain.

7 It must produce uniform windrows for faster more uniform drying.

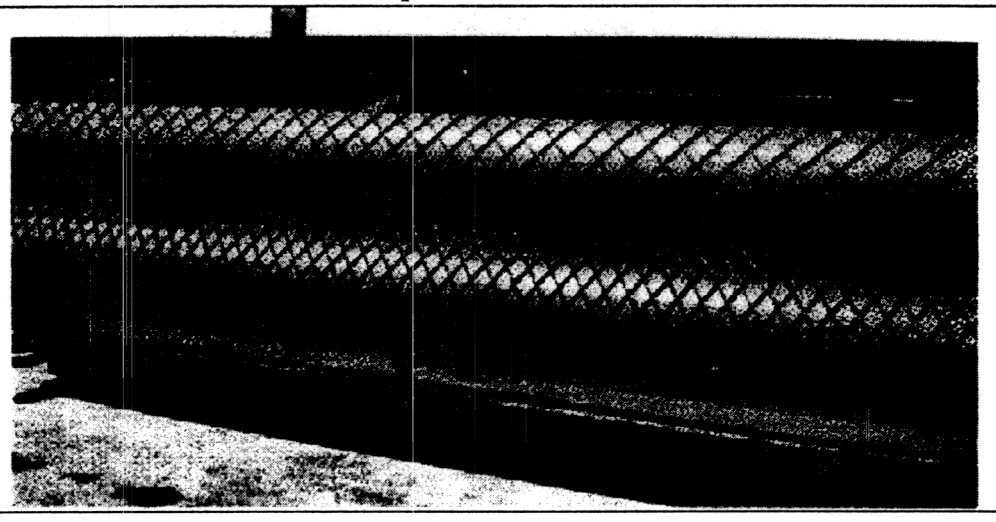
The entire research and development process was slow and trying. I tried a lot of things that didn't work. Quite often I'd be frustrated and discouraged, but I was driven by the need to reduce rain damage losses.

HOW IT WORKS:

The Crusher system consists of a set of specially designed conditioning rolls and a mechanism for applying pressure on the hay stem. The rolls, which replace the standard conditioning rolls in existing swathers and mower-conditioners crush under heavy pressure, yet have a feed-through rate roughly equal to that of conventional conditioners.

In the following picture of the Crusher, note that the rolls do not intermesh like standard conditioner rolls, but rather the top roll turns against the bottom roll without intermeshing. Through an airbag suspension system, air pressure is applied, pressing the top roll against the lower roll. Also, by being able to vary the pressure in the air bags, it allows the operator to adjust the pressure between the rolls for different crop conditions.

New Super Conditioner Rolls



The attaching brackets, new bearings, cores for the rolls, and the suspension system were all designed with quality, durability, and ease of maintenance in mind. After initial testing on my own farm, I asked the Extension Service at Oregon State University in Hermiston to conduct their own evaluation trial on the Crusher.

I'd like to share with you the report from Oregon State University.

1997-1998 "CRUSHER" EVALUATION TRIAL

Effect Of Harvest Technique On Alfalfa Drying Time

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Study Objective:

Comparison of the drying rates of alfalfa harvested with a "Crusher" super conditioner harvester with that harvested by conventional conditioner rollers under late-season conditions in the Lower Columbia Basin (LCB).

Background:

Circle C Equipment, of Hermiston, Oregon, has developed a harvester for alfalfa that cuts and crushes the stem, leaving the leaves intact and attached to the stem. Preliminary tests with this unit, which we will here-in refer to as "Crusher", indicated that this unit could reduce pre-bailing drying time for alfalfa harvested in the LCB 1/3 to 1/2 of that needed for alfalfa harvested by conventional conditioning rollers. If confirmed, this method of harvesting could reduce post cut field time by 2-4 days, reducing the risk of down hay being rained on. The shorter removal time could also reduce the likelihood of harvest damage to fast recovering varieties and perhaps allow for an additional cutting in some seasons.

Materials and Methods:

Comparisons of the drying rates of the two harvesters were made on alfalfa at the Hermiston Agricultural Research and Extension Center and in 2 commercial fields near Hermiston, Oregon. Five trials were conducted on the final seasonal harvest, with cutting dates ranging from October 6th to October 20th, 1997 (see **Table 1**). All fields were irrigated by center pivot, with the comparative sampling areas consisting of alfalfa on either side of various wheel tracks of the field (i.e., at HAREC the area between the second and third wheel track were harvested with the crusher, with the rest of the field being harvested by conventional means). Three samples per field were taken for each harvest method. Individual samples consisted of at least 4 handfuls of material taken at 20 paces apart as one walked around the pivot wheel tracks. Only the three wind-rows nearest the wheel track were sampled, with every effort being made to take a representative sample from each wind-row. Depending on the size track used, from 1/4 to 1/2 of the field was sampled by this method.

Samples were taken daily and immediately placed in a 1 gallon plastic zip-lock bag, and stored at 40°F until processed. The moisture content of each sample was determined by comparison of fresh weight with the weight after drying at 60°F for 2 days using the formula: (fresh weight - dry weight) / (fresh weight). Data obtained was statically analyzed by using SAS.

The weather during the trial period is presented on **Table 2**. It varied from cool and cloudy during the beginning of the trial to relatively warm and dry at the end, with one evening of ½" rainfall at midpoint of the first three fields. This cutting period was chosen because the cool nights, and sometime wet weather, offers less than ideal conditions for hay drying.

Results:

Samples ran through the "Crusher" had stems that were flattened but not otherwise mutilated. There did not appear to be any more leaf loss on the material ran through the "Crusher" than that on material handled the conventional manner. Alfalfa ran through the "Crusher" felt softer (i.e., offered less resistance to bending) and had comparable feed values (**Table 3**). Protein % was statically the same at the

5% level (n=10), with numerical protein value of hay ran through the Crusher harvester of 21.6% compared to 20.9% for the standard harvester (LSD of 0.90%). The swath rows of the crusher unit were slightly wider and more uniform than the standard unit which may account for some of the differential drying rates.

The daily change in moisture content of samples taken from each part of the fields is presented in **Table 4**. For the purposes of comparison, values below 20% were considered "baleable." In all cases the drying rate for material ran through the "Crusher" harvester was significantly faster than material conventionally harvested. This advantage was manifested despite the occurrence of ½" rain on the 3rd night for the first three fields.

On field one (Sherrel), material ran though the "Crusher" harvester could have been bailed about day 5, four days earlier than the conventionally harvested hay. Results were less dramatic on Field 2 (HAREC) probably due to the low tonnage on this field, with a two day advantage, and on Field 3 (Circle 4-1) there was a 2-3 day advantage. The occurrence of the cloudy weather and rain during the drying period of fields 1-3 certainly delayed the dry-down period of both types of harvested material, but exemplify the value of reducing the drying time even by a few days during this period of the year. In Field 1 bailing of the conventionally harvested hay was delayed for several days wind-blown hay had formed clumps what were difficult to dry out, and necessitated additional raking, further deteriorating the quality of the hay. No such clumping occurred on the "Crusher" harvested material.

Trials on Fields 4 & 5 were carried out on what is considered more ideal haying weather for such a late-season cutting. No rain, sunny weather, with light breezes. The differential drying rates of Field 4 is shown in Figure 1. On day 5 the "Crusher" harvested hay was ready to be bailed, where as the conventionally harvested material was still at 40% moisture, and could not be bailed for 4 more days. There was only a 2 day difference in Field 5, with the "Crusher" harvested material being ready for harvest on day 5, and the conventionally harvested material would have been ready by day 7, however, on day 6 there was rain, delaying the removal on the conventionally harvested material and deteriorating it quality.

Conclusions:

The alfalfa hay harvested with the "Crusher" harvester dried faster, and was ready to bail 2-4 days earlier than the conventionally harvested material. At harvest and while drying, its quality was equal or better than the conventional material. It was "softer," had similar or slightly better leaf retention, and required less raking. The ability to remove hay from fields 2 to 3 days earlier during this late-season period of unpredictable weather patterns, offers definite advantages worth considering.

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TABLE 1. SAMPLE SOURCE

Field	Location	Letter	Treatment	Harvest (day/time)		Sample area
1	Sherrell	A	Crusher	10/06/97	3:00 pm	Towers 1->2, 3 inner strips
1	Sherrell	B	Swather	10/06/97	3:00 pm	Towers P->1, 3 outer strips
2a	HAREC	C	Crusher	10/06/97	4:00 pm	Towers 2->3, 3 outer strips
2a	HAREC	D	Crusher	10/06/97	4:00 pm	Towers 2->3, 3 inner strips
2b	HAREC	E	Swather	10/06/97	4:00 pm	Towers 3->4, 3 inner strips
2b	HAREC	F	Swather	10/06/97	4:00 pm	Towers 1->2, 3 outer strips
3	Circle 4	G	Crusher	10/07/97	3:00 pm	Towers 5->6, 3 outer strips
3	Circle 4	H	Swather	10/07/97	3:00 pm	Towers 6->7, 3 inner strips
4	Circle 4	I	Crusher	10/13/97	11:00 am	Towers 4->5, 3 inner strips
4	Circle 4	J	Swather	10/13/97	11:00 am	Towers 3->4, 3 outer strips
5	Circle-1	K	Crusher	10/20/97	4:00 pm	Towers 7->8, 3 outer strips
5	Circle-1	L	Swather	10/20/97	4:00 pm	Towers 8->9, 3 inner strips

TABLE 2. CLIMATIC CONDITIONS DURING TRIAL

Date	Temp. (F) High	Low	Moisture (inches) rainfall	ET	Descriptive (at sampling time)
10/06/97	55	39	0.02	0.07	Sunny, breezy, cool (50-55 F)
10/07/97	62	44	--	0.14	Sunny, light breeze, cold (45-50 F)
10/08/97	65	36	--	0.08	Cloudy (thin high clouds) still air, cool (55-60 F)
10/09/97	66	44	0.33	0.11	Cloudy (1/2" rain previous night), breezy, warm (65 F)
10/10/97	61	37	0.02	0.10	Sunny, very light breeze, frost in morning, 60 F
10/11/97	60	44	--	0.12	Sunny with occ. clouds, breezy, 60-65 F
10/12/97	61	39	--	0.08	Cloudy (no rain), lt breezy, cool (65 F)
10/13/97	70	48	--	0.12	Sunny, warm (65-70 F), no wind
10/14/97	71	43	--	0.10	Sunny, warm (70-75 F) no breezy (ideal drying weather)
10/15/97	66	44	--	0.08	High clouds, no breezy, 60-65 F, no rain
10/16/97	69	40	--	0.09	Sunny, warm (70 F), no wind, no rain
10/17/97	73	43	--	0.11	Sunny, warm (70-75 F), lt breezy (5 mph), no rain
10/20/97	61	31	0.01	0.09	Sunny, warm, dry (ideal hay drying conditions)
10/21/97	60	32	--	0.08	Sunny, warm, dry (ideal hay drying conditions)
10/22/97	65	41	--	0.07	Sunny, warm, dry (ideal hay drying conditions)
10/23/97	60	42	--	0.07	Sunny, warm, dry (ideal hay drying conditions)
10/24/97	57	33	--	0.07	Sunny, warm, dry (ideal hay drying conditions)

TABLE 3 FEED ANALYSIS REPORT - Dry Weight Basis

	Crude Protein %	ADF %	Tri-State TDN %	RFV
Crusher	21.468	31.679	60.901	142.16
Standard	20.856	30.871	60.737	139.07
LSD	*0.899*	*1.287*	*0.846*	*4.702*

Sample size of 10 cores each

TABLE 4. SUMMARY OF RESULTS *1

		MOISTURE LEVEL (BY DATE)							
Hours from harvest:		0	24	48	72	96	120	144	168
Field - Treatment		10/06/97	10/7/97	10/8/97	10/09/97	10/10/97	10/11/97	10/12/97	10/13/97
1-A	Crusher	76.8%	74.1%	38.5%	57.0%	21.0%	16.7%	20.0%	
1-B	Swather	76.8%*2	76.6%*2	61.2%	62.0%	50.3%	39.6%	39.8%	
2-C&D	Crusher	74.8%	60.6%	25.5%	46.4%	18.1%	16.1%	20.8%	
2-E&F	Swather	74.8%*2	58.9%	37.9%	44.8%*2	31.6%	23.0%	25.9%	
3-G	Crusher		78.7%	63.6%	65.5%	41.6%	34.2%	28.6%	19.4%
3-H	Swather		78.7%*2	74.1%	70.0%	55.8%	44.9%	42.3%	27.3%
	Date:	10/13/97	10/14/97	10/15/97	10/16/97	10/17/97			
4-I	Crusher	73.4%	50.7%	34.1%	25.4%	19.4%			
4-J	Swather	75.1%*2	60.7%	53.1%	42.8%	39.3%			
	Date:	10/20/97	10/21/97	10/22/97	10/23/97	10/24/97			
5-K	Crusher	69.30%	46.80%	26.20%	22.05%	15.21%			
5-L	Swather	69.60%*2	63.60%	46.80%	33.28%	22.70%			

*1 - differences on all but initial sampling dates (and where marked *2) significant at P=0.05% level

*2 - not significantly different at P=0.05% level

End of OSU Report

I was able to conclude from this report that the Crusher had no negative impact on the alfalfa. Ready to run the Crusher on a larger scale, I ran the new rolls on four swathers all this last season on my own farm in addition to running two swathers using standard conditioning rolls to maintain a season long comparison.

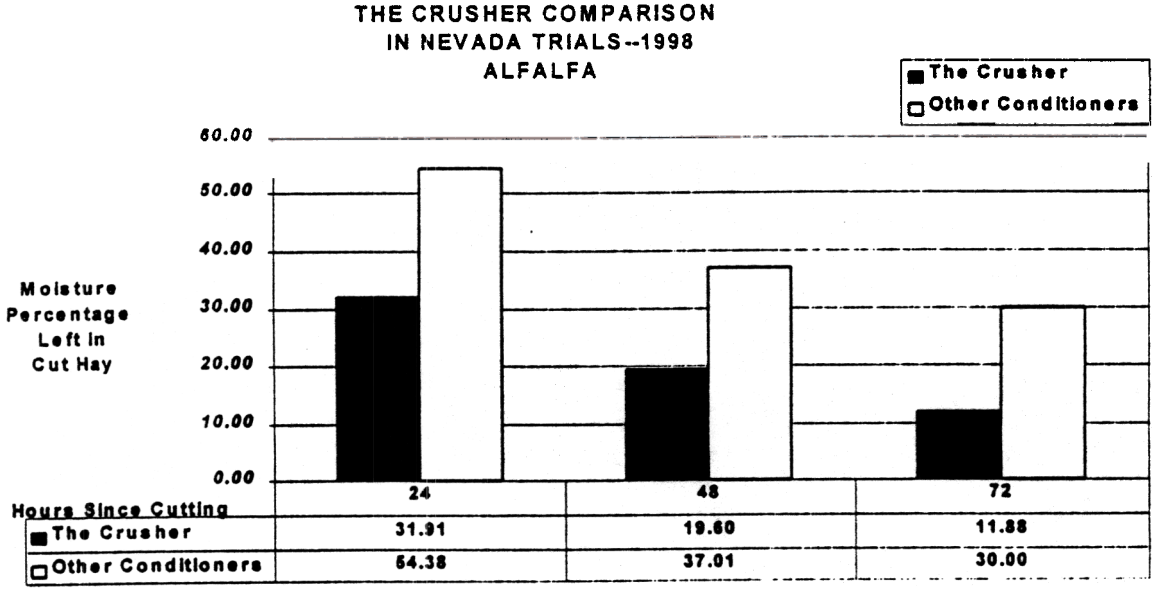
Careful monitoring and comparison of the crusher with standard conditioners showed that I had met my goals. Thus, we were ready for additional trials in various states with various farmers on various crops.

DRYDOWN TRIALS

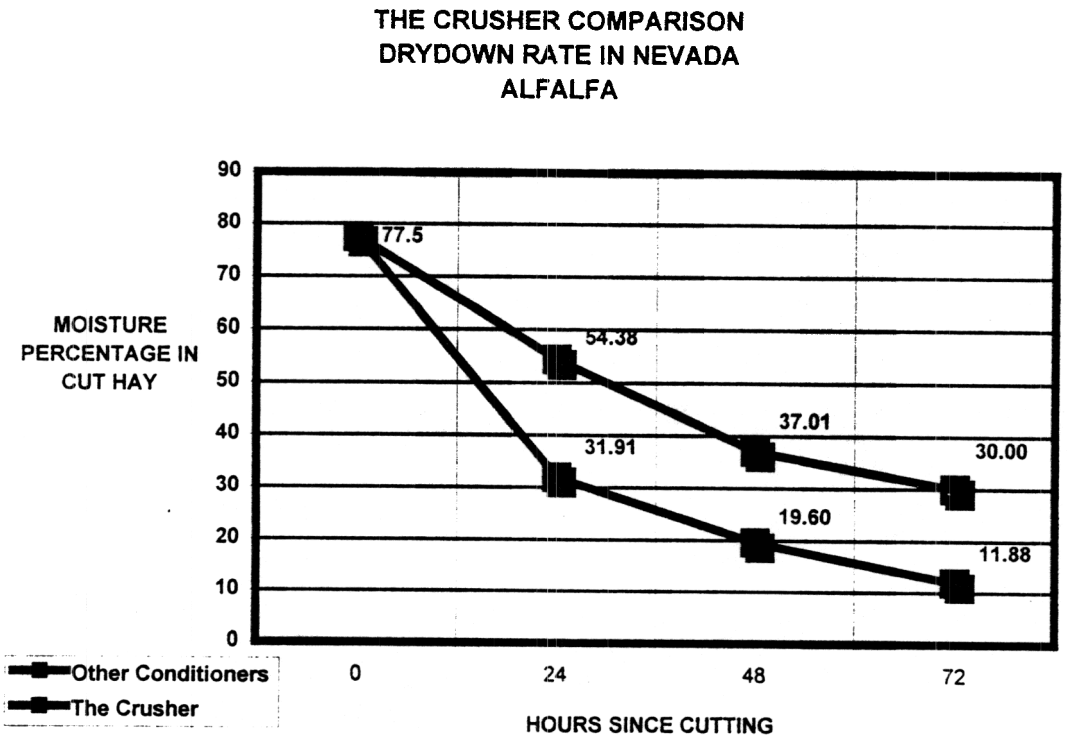
Running the Crusher side by side with standard conditioners, every trial showed the hay conditioned with the Crusher dried and ready for baling one or more days sooner. Even when rain came shortly after cutting, hay conditioned with the crusher dried faster when compared with standard conditioned hay. Growers everywhere have been impressed with the results.

Although conditions vary from state to state, such as elevations, humidity, and weather patterns, the results have always been the same: When using the Crusher, drydown time is reduced from that of the standard conditioners. In several cases, the Crusher conditioned hay was baled and out of the field, but rain kept the other hay unbaled in the field for days afterward, with salvage sometimes impossible.

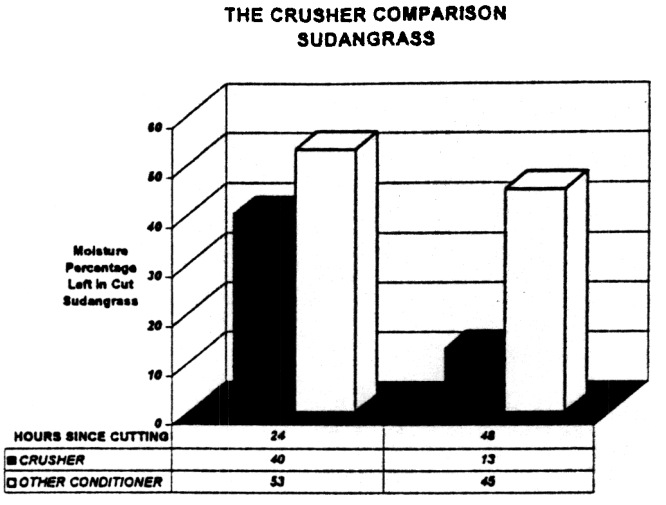
We conducted several demonstrations in Nevada. The chart shows the combined results of these trials. Note that the hay conditioned with the Crusher could have been baled shortly after 48 hours from cutting while that conditioned with the standard conditioners could not have been baled even after 72 hours. In fact, the Crusher hay was almost as dry at 24 hours as the other hay was at 72 hours.



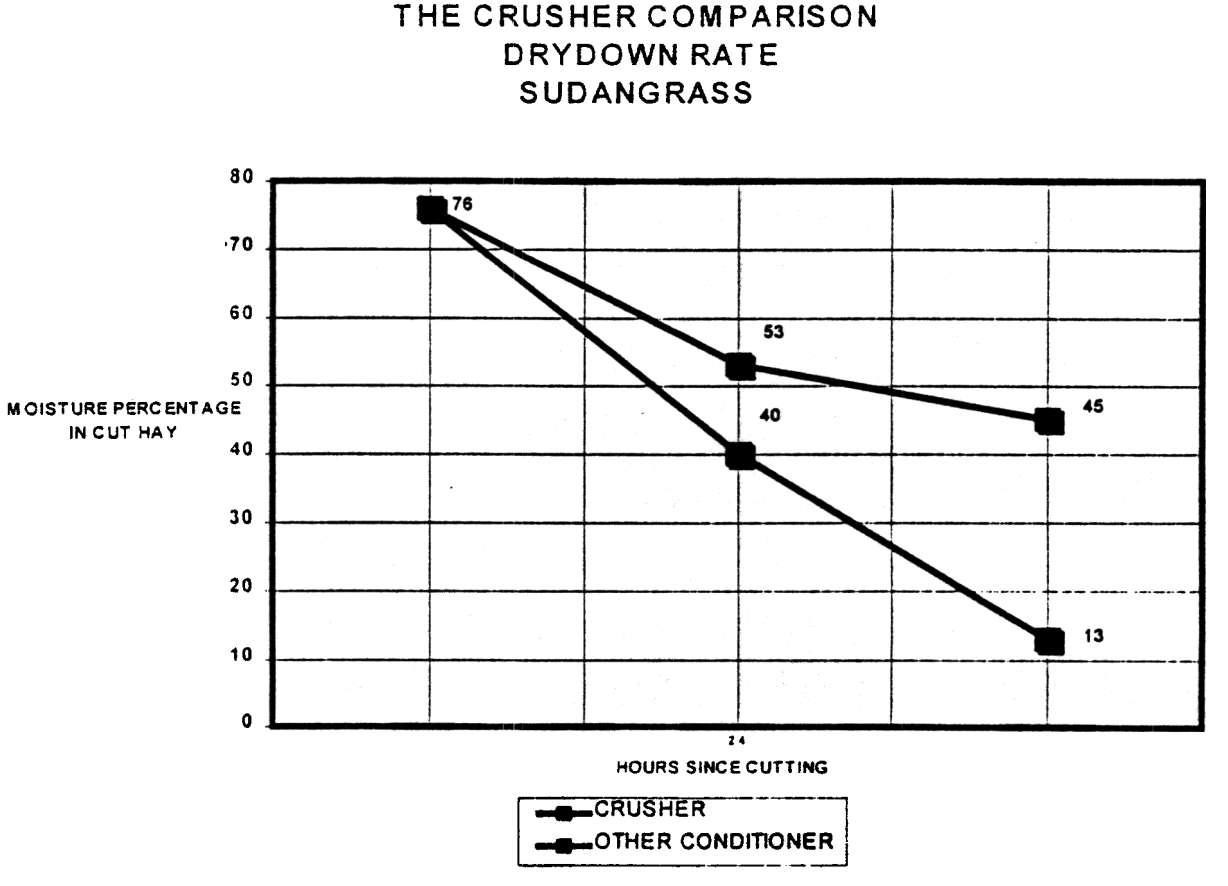
In this next chart note how much faster the rate of drydown is when using the Crusher.



Farmers of other types of hay started taking notice of the results of the crusher. In California, we found Sudangrass farmers with the problem of getting the joints dry. The Crusher was able to again completely crush the entire stalk including the joints. Sudangrass growers found great improvements in drydown times in their crops. The next table shows the results.



Again, in the following line graph, note the increased rate of dry down when using the crusher.



ADAPTABILITY TO OTHER SWATHERS

So far the Crusher is available for New Holland, Case IH, Hesston, and MacDon. Almost all swathers that have wide conditioners, whether self-propelled or pull type mower-conditioners are able to use the Crusher. We are currently working to make it available to other makes and models soon.

BENEFITS OF THE CRUSHER

In both the Oregon State University trials and the individual trials that we have conducted in various states, we have found the same benefits. Because growers are able to bale their hay sooner, they have less rain damage losses.

In the irrigated fields, because of faster removal from the field, the water can be returned sooner to the field. Consequently with good management, growers see increased yields.

Because of less time in the field, growers report an upgrade in hay quality with improved color due to less bleaching. Thus, there is increased marketability.

The end result is increased revenues due to overall better quality hay. However to receive all the benefits from this equipment it will require close management and timely harvest practices

CONCLUSION

The results of our drydown trials substantiate the conclusions expressed by Oregon State University Agricultural Research Station. All experience in using the Crusher on various crops and under varying conditions show the Crusher to be a valuable improvement in the harvest of all types of hay and forage to give bigger yields and better quality hay.

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