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Predicting Moisture Content of Wild Rice During Parching

James J. Boedicker

"Parching" is a major component in wild rice processing operations. Parching serves three distinct functions: 1) drying to prepare the grain for hulling and, ultimately, long term storage, 2) gelatinization of starch giving the inside of kernels a glassy, translucent appearance and 3) development of a toasted flavor depending on parching time and temperature conditions. In Minnesota, most wild rice is parched in propane-fired, batch-type, rotary drum parchers. Batches typically range from 500 to 800 lb of 45 to 50 percent moisture grain. Parching time is about two hours.

In 1990, research was initiated in cooperation with Dr. Cletus Schertz, Agricultural Engineering Department, St. Paul, to try to find a practical way to estimate moisture content of wild rice in a parcher during the critical final few minutes of the process as grain moisture content drops below 10 percent. This work was undertaken in response to a need expressed by processors for a more reliable method for determining when to terminate parching of individual batches to prevent needless overdrying and the associated loss of saleable product mass. Traditional methods to test for "doneness" consist of biting or breaking a few kernels to check hardness and may also include squeezing a handful of grain to "check" temperature. These methods yield a good quality product, but final moisture content is frequently 2 to 4 percentage points lower than preferred (varies from 7 to 10 percent.) Each additional one percentage point of moisture content below some preferred minimum equates to about one percent less finished product and hence, equally less gross income for the seller. The effect on net profit is obviously much greater.

One approach investigated in 1990 for estimated moisture content during parching is the use of electronic moisture testers. Evaluations were conducted with hot wild rice samples taken directly from parchers during normal parching operations at a wild rice processing plant. Two types of commonly used testers were evaluated but neither appeared capable of providing a sufficiently accurate estimate of moisture content below the 10 percent level. However, prior to evaluating the testers, temperature was taken of each grain sample and later compared to the oven dry moisture content for that sample. Emerging was a tightly fitting, inverse relationship between grain temperature and moisture content suggesting that for any given set of parching conditions (parcher design, load size, etc.) temperature might be a satisfactory indicator (predictor) of grain moisture content as parching nears completion.

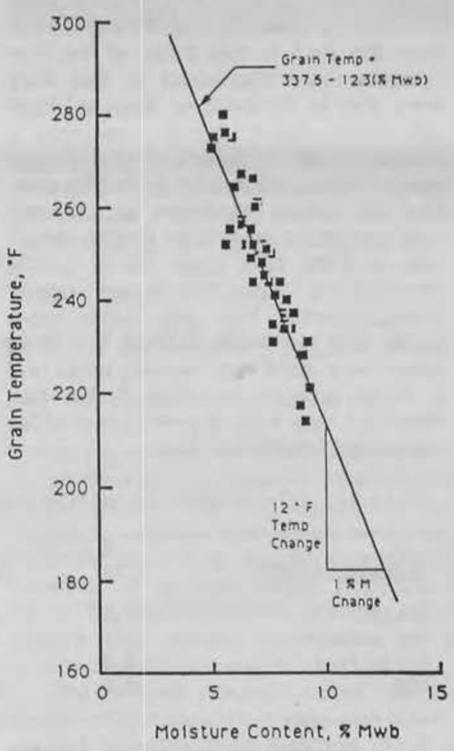


Figure 1. Grain temperature vs. moisture content of wild rice during the final few minutes of parching.

To further evaluate the potential for using grain temperature to predict moisture content, additional testing was conducted at three processing plants in 1991. Temperature vs. moisture relations were similar for all three plants. Figure 1 shows a plot of all temperature and moisture content data obtained in these tests for samples below 10 percent moisture. Also shown is the linear relationship that best fits these data. With this relationship, temperature could have been used to predict moisture content to within one percentage point of the actual (oven dry) value for all except one sample.

With these findings, research shifted to a search for a practical way to measure grain temperature in parchers. Three methods were considered: 1) a cup sampler instrumented to measure grain temperature, 2) a hand-held, infra-red temperature sensor to be aimed at grain in the parcher and 3) one or more stationary temperature probes mounted inside the parcher. Advantages of the stationary probe method include minimal operator influence and the potential for incorporating continuous temperature readout as well as signal activation and/or burner shutdown when a preset temperature is attained.

A stationary temperature probe was installed and tested in a parcher in 1991. The probe was designed to be self cleaning and to provide good probe-to-grain contact in the parching drum. Performance was satisfactory from a mechanical standpoint.

A system of four temperature probes (See Figure 2), patterned after the 1991

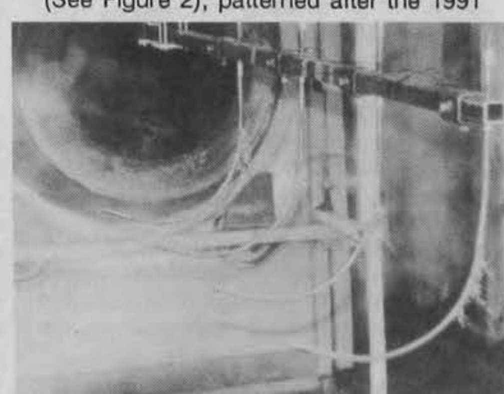


Figure 2. System of four temperature probes after removal from parcher drum.

design, was installed and tested in a parcher in 1992. Probes were uniformly spaced from front to rear within the parcher drum. Similar to previous results, tests showed temperature probe readings could be used to satisfactorily predict grain moisture content as parching nears completion for a given set parching conditions. However, tests did show final grain temperature to be about 35 F higher and final grain moisture, 1.5 to 2 percentage points lower near the rear of the parcher drum than near the front. These results point to the potential for improved moisture content uniformity in the parcher through improved mixing action and/or more restriction of convective air exchange (cooling) through the front opening of the parcher.

We understand grain temperature measurements were successfully used at two processing plants in 1992 to indicate when to terminate parching of individual batches. Dr. Schertz and I thank those processors who have supported and assisted us in the conduct of these studies.

Round Bale Silage

Russell Mathison, Senior Scientist

Some forage producers in northern Minnesota are showing interest in making silage in the form of large round bales (balage). This form of storing forages seems to address two perpetual thorns in the side of forage producers. First, compared to dried hay, ensiling offers an opportunity to harvest higher quality forage because it minimizes harvest dry matter losses and field drying time, both of which can detract from forage quality. Ensiling large round bales also offers a silage storage system without the high initial cost of a permanent silage storage structure.

There are several types of balage systems. Four types were evaluated in a research study done in Michigan's Upper Peninsula by Dr. Ben Bartlett of Michigan State University[1/]. Following is a brief summary of his research.

Experimental Procedure

The four systems compared were:

1. Wrap--individually wrapped bales, wrapped by machine with stretch-type plastic.
2. Bags--bales were placed in individual plastic bags.
3. Spear--bales were hand-wrapped with stretch-type plastic around the round sides, then piled end to end.
4. A pile system--two rows of bales on the ground with another row on top, all covered with 6 mil Plastic.

All bales in the storage system came from the same field in each of two locations from an alfalfa grass mixture (1/3 to 1/2 alfalfa). Data was collected on three bales from each system at two locations for two years for a total of 12 bales per system. In the multiple-bale systems, data was collected from interior bales. Data collected included bale weight, dry matter (DM) percent, crude protein (CP) and total digestible nutrients (TDN) at baling time and after 100 days in storage. Visual quality observations were also made after 100 days in storage and the cost per bale for each system was calculated.

RESULTS

Forage Quality

Table 1 shows the average weight and quality data for the 12 bales in each system. The most important thing to note from the data is that three of the four systems were successful in that they were able to eliminate air (oxygen) from the forage mass, thereby enabling a successful fermentation of the forage without much dry matter or quality loss. The pile system, however, experienced nearly a 22% loss in TDN (13.97 weight loss + 9.3% TDN loss). Visual quality observations supported forage quality measurements. The pile bales were moldy and not worth feeding, the wrap bales were mold free, the bag bales had a small amount of mold if the bag remained hole free, and the spear bales were mold free if piled tight.

Cost Comparison

The comparisons in Table 2 are based on an 800-bale season with 100 bales stored per day. The costs considered are those after the bales are delivered to the storage site, that is, those costs unique to storage of balage. The fixed costs for the wrap and spear system are for bale wrapper and bale handling spear, respectively.

Discussion

Dr. Bartlett points out it was not the intent of his research to identify the 'best' round bale silage storage system, but rather to identify the strengths and weaknesses of each system. Following is his summary of these significant points.

Table 1. Bale weight and quality changes.

	% change from pre to post storage			
Storage System	Wrap	Bag	Spear	Pile
Weight	0.8	-5.9	-3.9	-13.9
Dry matter	3.7	3.6	0.2	5.1
Crude Protein	0.4	2.5	0.5	1.4
TDN	-0.6	-0.2	2.9	-9.3

Table 2. Cost comparison of storage systems.

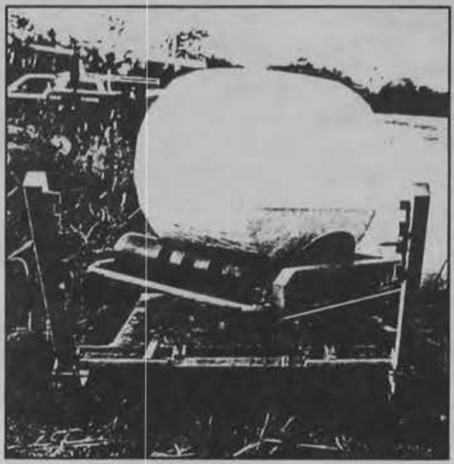
		Variable costs		Total cost
	Fixed costs	Plastic	Extra labor	per wet bale
WRAP	$8000/5-yr life = $1600/yr -:- 800 bales/yr	$90/roll 20 bales/roll	6 hr x 8 days x $5/hr -:- 800 bales	
Per bale	$2.00	+$4.50	+ $ .30	= **$6.80**
SPEAR	$2000 5-yr life = $400/year -:- 800 bales/yr	$90/roll 25 bales/roll	6 hr x 8 days x $5/hr -:- 800 bales	
Per bale	$.50	+ $3.60	+ $.30	= **$4.40**
Bag	-0-	$8.50/bag 1.5 yr avg useful life	12 hr x 8 days x $5/hr -:- 800 bales	
Per bale	-0-	+ 5.67	+ $.60	= **$6.27**
PILE	-0-	$99 for 100 bales 30 ft x 100 ft 6mm	3 hr x 8 days x $5/hr -:- 800 bales	
Per bale	-0-	+ $1.00	+ $.15	= **$1.15**

The pile system may work well with persistent attention to the plastic cover. The potential for considerable forage losses exists because one hole can affect several bales. The strong point of this system is the low plastic cost per bale.

The spear system works well if the bales are tightly piled end to end. The system works best with two people, one running the tractor and one wrapping the bales. This system requires no extra equipment, since most producers have a spear.

The bag system can work provided the correct size bags are used, they are sealed tightly and no leaks develop. Bagging bales takes three people to work smoothly. One on the tractor and two bagging. With care, some bags may be reusable.

The wrap system gave the most consistent results, was faster, and required only one person. The weakness of the system is the wrapping machine investment.



Conclusions

The research by Dr. Bartlett indicates that round bale silage systems have potential in northern Minnesota, because our climate is similar to that of the Upper Peninsula of Michigan. Certainly there are other arrangements of the pile system that may work better than the one tried. However, the thing to remember with any silage storage system is to practice good ensiling techniques. Roll bales tightly at the correct moisture (55 to 65%), cover at least the same day, cover them well and keep them covered, and repair any holes as soon as they develop (duct tape has worked well for many producers). Storage site selection is also important. The site should be level or well drained, and free of critter habitat (they like to chew holes in things). Balage systems offer the opportunity to harvest high quality forage because you can start earlier and work longer days, with the obvious benefit that livestock eating this forage will either perform better or maintain performance with less purchased supplements.

1/ Round Bale Silage: Analysis of Four Storage Systems by Dr. Ben Bartlett, District Extension Agent, Upper Peninsula Extension Center, Michigan State University.

Update on the Development of a Biological Control for Purple Loosestrife

Robert F. Nyvall and An Hu

Purple loosestrife (Lythrum salicaria) is an exotic plant introduced from Europe in the 1800s by homesick immigrants that wanted to grow a familiar plant from the "old country." Since then, purple loosestrife has spread throughout most of the United States and is found in marshes and wetlands throughout Minnesota. Purple loosestrife is an aggressive plant that is well adapted to overwintering in Minnesota and is capable of producing hundreds of thousands of tiny, viable seeds. The consequence of purple loosestrife growing in an area is useful native vegetation is crowded out creating a monoculture useless to wildlife. Purple loosestrife grows in wet areas and is frequently confused with fireweed, a native plant, that also has light purple flowers and can be found growing along highways and upland sites throughout Minnesota.

Currently the only approved method to control purple loosestrife is application of the herbicide glyphosate (Rodeo). This raises several issues such as the placing of a chemical herbicide in public waters and the cost of chemical and its application.

Since the summer of 1991, efforts have been underway to develop a mycoherbicide that would be a biological control of purple loosestrife. Mycoherbicides consist of fungi naturally found in the environment that pose no hazard to native vegetation, wildlife or water. The fungus is manipulated in some fashion, usually by putting large quantities of fungus spores grown in the laboratory in a growth media and applying them to the target plants. After the application and hopefully death or injury of the weed, the number of fungus spores (sometimes referred to as the fungal population) drops to a normal level naturally found in nature and poses no hazard as a chemical herbicide might.

The research process of developing a useful mycoherbicide is long and laborious. Fungi that cause leafspots or other diseases are first isolated from purple loosestrife, gotten into a pure culture, tested for pathogenicity to the target plant and identified. Approximately 3,000 fungal cultures have been isolated from purple loosestrife plants at 16 sites throughout Minnesota. In nature symptoms of disease on purple loosestrife caused by fungi consist primarily of leafspots that originate on lower leaves and progress to upper leaves during the summer. Initially spots are irregular to round, purple to dark brown, and 1 to 5 mm in diameter. Later spots enlarge to an average diameter of 1.5 cm, are irregular in shape and become tan to light brown with a purple to dark brown border. Spots often coalesce, forming large necrotic areas on leaves. The center of some spots falls out giving a shothole appearance to the leaf. Some spots have a target appearance with dark brown rings in a tan spot. Individual plants may have numerous spots that defolilate the lower leaves toward the end of the growing season.

Several cultures have been tested for their pathogenicity or ability to create disease on purple loosestrife plants. As part of our research, we have had to learn to grow the purple loosestrife plants in our laboratory. This has not been an easy task since the purple loosestrife seed is less than 1 mm in length and the seedlings are extremely delicate until they are about 1 month old. Secondly, we have had to learn to produce large numbers of fungal spores to inoculate the plants. Most of the cultures we have isolated will not sporulate unless subjected to 12 hours of fluorescent light and 40 to 60 minutes of uv light at 360 nm for 2 consecutive days. To date we have identified at least 2 and possibly more cultures that have promise as mycoherbicides. In the laboratory, these fungal cultures have either killed 2-month old purple loosestrife plants or made them so severely diseased that plant growth is retarded.

Our future work will concentrate on seeking and evaluating more fungal cultures. The cultures that show promise as mycoherbicides in the laboratory will be tested in the field as early as this summer. Once cultures have been identified, work will also be done on other aspects such as application techniques, storage and improved pathogenicity. Hopefully, if our research proves successful, we will have a mycoherbicide that will eliminate purple loosestrife as a pest to our wild areas without creating an environmental hazard.

News From North Central

David L. Rabas, Superintendent

By the time you receive this issue of the Quarterly spring will have finally arrived. Spring is a particularly exciting time at a research station. It is a time when plans made during the long cold days of winter can finally be implemented. It is a time of renewal as perennial crops, shrubs and trees show signs of having survived another long winter. For those of us who work with the soil it is a time to till and to plant and to watch as new growth begins.

This spring was also a time for renewal of memories of times gone by at NCES. On March 23, thirteen "old timers" met at the experiment station to discuss and record memories of the North Central Experiment Station and School of Agriculture. The group was composed of class members of the school and employees from the school and experiment station from the thirties and early forties. Those present were Eunice "Wink" Cartwright, David Patrow, Glen R. Swensen, Don Burt, Archie L. Johnson, Louis and Audrey Hansen, Dan Carey, Herbert "Spike" Shumaker, Don Childs, Oliver Juntunen, Mr. and Mrs. Harry Tisdell, and Evelyn and Llewellyn Reese. During the meeting the room was filled with stories of classmates and school and work experiences at North Central. Stories of horses and livestock and crops, of school, grain judging and athletic events--won and lost, would fill a dozen books. It was an interesting and rewarding meeting for me and everyone involved. I want to take this opportunity to thank those "old timers" for taking time to share their memories with us. It is useful to be reminded of our station's role in developing outstanding Guernsey cattle, pioneering artificial insemination, breeding the Minnesota No. 1 hog and so many other contributions to agriculture and forestry in the state and area.

In addition to those who were with us on the 23rd several other "old timers" wrote to say hello. George G. Roadfelt (1931-33) wrote a long letter about people and activities at the station in the early 1930s. Mr. Roadfelt has given permission to share the letter with anyone who is interested. You may obtain a copy by writing to me at the experiment station.

April 16,1996, marks the 100th anniversary of the North Central Experiment Station. I look forward to working with our readers and staff as we recognize this significant milestone in our station's history.

Alumni News

Tom Carpenter

Hope everyone had an enjoyable winter with good health. Spring is just around the corner and that means exciting and interesting research is waiting to get started. I've been working in the horticulture department for 28 years at North Central Experiment Station and a total of 31 years with the University of Minnesota, not counting the 4 years as a student employee. I did put in approximately 6 months with the North East Experiment Station in Duluth before serving in the USMC. In all, I've seen many changes and additions to NCES. A lot of my working motivation and leadership was gained by working with Superintendent Bill Matalamaki and Horticulturist Nils Grimsbo. Dave Wildung came on the staff in 1970 as Horticulturist and Kay Sargent as Junior Scientist in 1982. The three of us have put together a good horticulture program with our garden plots being named as an All American Display Garden in 1990. In all my years at North Central I've put a lot of pride in seeing this place look sharp. I am hoping to work another 4 years and then join the snowbirds.

Class History Quotes From The *Evergreen*

1953 We were very glad to see Dan Carey out of the army and back in school with us.

1956 The history of our class begins in the fall of 1952. Of the 24 boys graduating this year only six were with us at that time, namely; Gordon Fuller, Gordon Bickford, Robert Jenson, Arlen Krook, Robert O'Brien and Dennis Sraba.

1957 Mr. Blanchard came over from Itasca Junior College two days a week to direct our glee club.

We received a letter from Bob Sather, Class of '45. He tells us that Myra Smart, who worked in horticulture from 1942 to 1946 at NCES, was seriously injured in an automobile accident in Montana in July, 1992, while driving to vacation with his family in Wisconsin. Bob thinks she would appreciate hearing from friends and alumni. Her address is Myra E. Smart, Good Samaritan, Room 102, 640 N. Eisenhower St, Moscow, Idaho 83843.

Seeking More Purple Loosestrife Sites

I would like to thank everyone who helped me identify purple loosestrife sites in northern Minnesota this year. Your cooperation was greatly appreciated and I was able to gather samples from many new areas or areas previously unknown to me. If you know of a purple loosestrife site please send a short note with directions or a map (doesn't have to be fancy) to me, Robert Nyvall. Who knows? Maybe the organism we isolate from your site is the one that sucessfully controls this weed in the future without the use of chemical herbicides.

Coming Events

Minnesota Beef Cattle Improvement Association tour and meeting, June 5, 1993.

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DR. DAVID L. RABAS
Superintendent

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