

Progress Report
**Effects of Wrapping Materials on Temperature and Quality of Hydrated
Double Compressed Alfalfa Hay for Export to the Pacific Rim**

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Objectives:

1. To determine effects of four wrapping materials on internal bale temperature, weight and forage quality changes of double compressed bales at two moisture concentrations and stored in shipping containers for export.

Materials and Methods:

Using commercial hay industry standards, large '1-ton' rectangular of fourth cutting alfalfa bale packages were harvested near Silverton, OR. Initial bale dry matter (DM) concentrations are 75-80% DM (moderate DM forage) or 60-70% DM (low DM, i.e. hydrated forage). Initial bale moistures were determined using the microwave oven technique. Bales were transported from the field to a protected storage area for processing. Large bales were compressed a second time, i.e. double compressed using Steffen's Hay Systems presses. Double compressed bales of each DM (moisture) treatment were randomly divided into bales completely wrapped in Tyvek, Ag-Bag, and stretch plastic to make them airtight. Bales wrapped in damaged stretch plastic were used as checks. Each bale was weighed on a platform scale, +/- 1-kg. During processing forage cores were collected from each bale using a hay sampler and stored in zip-lock bags in a freezer. A thermocouple was inserted into the center of each bale to continuously monitor internal bale temperatures during storage. Double compressed bales were stored in a 6.1-meter (20') commercial shipping container. Additional thermocouples were installed both inside and outside of the container to monitor ambient conditions. Shipping containers remained in Silverton for 8 weeks when bales will be removed, weighed, cored, and photographed. Any moldy/spoiled forage were sampled and frozen. Cored and sampled forages were oven dried and ground for planned forage quality analysis using NIRS and wet lab methods for crude protein, NDF, ADF, lignin, ADIN, pH, lactic and volatile fatty acids, various fungi and molds. Temperature, weight, and quality samples will be analyzed using SAS as a completely random design with treatments of baled forage at 2 DM's, 4 wrappings and 8 replications.

Practical implications:

Washington's export hay industry has been relatively stable compared to other sectors of the agricultural economy. A market analysis of export potential of successfully exporting

hydrated forage, a new alternative forage product, to the Pacific Rim would be combined with forage export data from both the IMPLAN data source, and from data on forage exports by U.S. Customs District and others sources. These data will provide the most accurate picture of possible Washington based forage exports and how much they will be expected to expand under several alternative scenarios.

A trade barrier to exporting hydrated forage products is the fear of spontaneous combustion with lower initial DM. Spontaneous combustion occurs when wet baled or dry baled forage is re-hydrated, ignites. Serious damage to property and death may occur due to spontaneous combustion, raising concerns among hay growers, ports, exporters, shipping companies and destination customers. Hydrated forage should retain more nutritious leaves and higher nutrient content, and be more palatable for Pacific Rim dairy and livestock and increasing their animal performance. Domestically we enjoy these same advantages through ensiling hydrated forages, then using it directly on-farm. Leaf shatter is a disadvantage of making dry hay with alfalfa as leaves dry faster than stems and shatter during the raking and baling process. Monitoring internal bale temperatures during storage is critical to detect a treatment's potential for spontaneous combustion. Research conducted last year with double compressed alfalfa hay indicated bale temperatures were about 5°C lower than single compressed hay. At no time did a double compressed bale treatment reach a danger point for fear of spontaneous combustion. This was not the case with some single compressed hydrated bale treatments. With lowered fire risks and increased transportation efficiency, double compressed hydrated forage has an excellent chance of being successful. The results will also aid in developing temperature guidelines for exporting hydrated baled forage for exporter.

We do not think the major forage export competitors to the Pacific Rim: Canada, Australia, China and Chile are working towards a newer export forage product as being proposed here. An enhanced forage product will provide PNW growers and processors a competitive advantage to obtain greater market share.

Value to Washington exports:

The PNW is a unique area with the ability to grow high quality forage in combination with double compressed processing. This unique ability allows for the improvement of hay products for both the domestic and export market. PNW hay is shipped daily to Pacific Rim dairy and livestock customers and is considered a precious import. The biggest customer of baled hay is Japan importing over 2.0 million metric tons in 2002 (Japan Trade Statistics). The second highest importer is Korea with about 531 thousand metric tons (Korea Trade Statistics) followed with a smaller amount for Taiwan with 223 thousand metric tons (Board of Foreign Trade, Taiwan Trade Statistics). About 73% of Japanese hay imports or over 1.5 million metric tons of baled hay was imported from the US. About 58% of that total is shipped from the PNW while the rest was shipped from the PSW. About 12.2 million metric tons of hay was produce in the PNW in 2002 of which 10% was exported (USDA-NASS, Port of Portland). Estimates for forage exports from Washington are about 25% of the states total hay production or about 773 thousand metric tons. The 9% are for the PNW and the 25% are for Washington hay. The value of hay from the US in Japan was placed at about 218 dollars per metric ton. This value includes

hay price to the grower, plus processing and shipping. Currently, prices to growers range from \$100 to \$130 per ton depending on forage quality.

Hay demand in developing economies is growing as consumers demand more animal proteins. Although Pacific Rim countries have imported more meat products, they have chosen to produce their own fresh milk. This requires dairy cows, which prefer at least half their diet in forages. Many Asian nations do not have the resources to efficiently produce quality forages for their dairy herds and other livestock. In addition, international shippers have problems finding backhauls for the return of vessels carrying goods to US consumers. To fill capacity, shippers often discount freight rates for hay, helping the growth in hay exports.

This project is directed at the enhancement of a product that will benefit the grower, exporter, and customer. The grower removes forage faster from his field providing higher forage quality. The exporter uses the smaller container without going over weight limits. The exporter and producer should increase profit margins and the consumer realizes increased milk production. Rain damaged hay reduces value about half and may not be accepted for the export market. The Japan dairy prefers first cut hay because of its higher forage quality. Much of the first cutting hay in Washington in 2002 (and in 2003) was rain damaged due to the length of time required for drying. Forage quality of second cutting could be improved to meet quality preferences in the Asian market and substitute for rain damaged first cut hay.

To put some rough estimates on the potential value of this process, assume the enhanced forage product allows for a 20-30 percent increase in value of hay to the export market. As previously noted, forage exports of 773 thousand metric tons in Washington at an average of 120 dollars a ton is derives just over 92 million dollars as the dollar value. An increase in forage exports of 25 % would be an increase of 23 million dollars for Washington's hay producers alone.

Integrating the change in estimated forage exports with a Washington regional economic input-model will generate estimates of the economic impact of these scenarios. Here the direct increase in value to Washington hay growers; processors and shippers will be used with the input-output economic model to estimate the ripple (indirect and induced) effect on the Washington economy. Estimates of economic impact will include the expected change in Washington sales, income and jobs throughout the economy as well as changes in the agricultural, processing and transportation sub-sectors.

Results:

Quality data has not been analyzed as of December 7, 2004. However, it was obvious that hay wrapped in Tyvek material was unacceptable as molds developed in the hay bales at both moisture levels. Ag-bag and bales thoroughly sealed with stretch wrap appeared to have no damage. The check bales wrapped in damaged stretch plastic were spoiled only at points of damage.