DRYING WINDROWED ALFALFA WITH CHEMICALS

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I. Background

Losses in the making of alfalfa may have been extensively measured and documented.

Under the most favorable of conditions, the losses of the nutrients in the growing plant are about 20%--i.e., the hay contains, on an acre for acre basis, about 20% less nutrients than were contained in the growing plant.

Under less favorable conditions, which are generally produced by rainy or cloudy weather, a humid environment, or the shorter days of late fall and early spring, the losses in nutrients often reach 40%.

If the weather is really adverse, the loses can exceed 100%--with the hay crop having a salvage value which is less than the cost of the haying and transport operations.

Any substantial reduction of these losses must be dependent on reducing the time during which the cut forage is exposed to the weather elements.

Furthermore, in the particular case of alfalfa and other temperate climate legumes, the reduction of haying losses is also dependent upon reducing mechanical leaf losses. Typically, the leaves dry about five times more rapidly than the stems, so that alfalfa with an average moisture content of 19% may have the leaves at 10% moisture and the stems at 30% moisture. Attempting to bale under these conditions results in large losses of leaves--the most valuable part of the plant. The practice of night baling in the more arid areas of the West is one response to this problem, but night baling is impossible in many areas, of little help in other areas, and inconvenient in all areas.

Fenn Farms at Elkton, Oregon, is located about 30 air miles from the Pacific Ocean. In spring and fall, the problems of a humid climate are encountered. In midsummer, the characteristics of an arid climate are present.

This environment has provided a major challenge to the production of high quality alfalfa hay, and it was there that the developments which will be described to you have taken place.

What I will describe is a system for producing hay in which the time interval between cutting and baling is reduced by more than one-half. Furthermore, the process greatly accelerates the drying rate of the stems so that the stems and the leaves dry at approximately the same rate.

The result of this system is a much higher level of nutrient conservation, and a much lower level of risk from adverse weather.

Before going into the technical description, a few words about the history and status of this program seem desirable.

During the 1972-1979 period, Dr. Jeff Tullberg at Queensland Agricultural College, Australia, performed scientific studies on the acceleration of legume hay drying by the application of chemicals simultaneously with the cutting of the forage.

Upon my inquiry in the summer of 1979, Dr. Tullberg generously provided a description of his work to that date. Recognizing that Tullberg's work was aimed at scientific

knowledge while my needs as a hay producer were for economic and production goals, branched out into my own development program, chemical and mechanical.

My objective was the development of a chemical system and an applicating system which were suitable for commercial hay production on an economical and predictable basis. My research has produced its own scientific results which will in time be reported in recognized technical journals.

By the summer of 1980, I was able, through using my system, to produce commercial quantities of extremely high quality alfalfa hay on a production basis, with the operations performed by hired farm employees.

In 1981, my system was tested on a broad geographic basis, including commercial farms. Commercial test locations included the Columbia Basin, Texas, New Mexico, and Florida

Scientific tests were performed at the Universities of Florida, Maryland, and New Hampshire, and at the USDA Dairy Forage Research Center at Madison, Wisconsin.

In general, the test results were consistent, and corroborated the results obtained at Fenn Farms.

In view of the affirmative test results, plans are now being made for initial commercial distribution of the system in 1982.

II. Technical Description

The Fenn system for accelerated hay production utilizes the application of chemicals to the forage as the forage is being cut.

The chemical solution consists of a soluble powder dissolved in water. About 8.5 lbs of dry chemical and 15 gallons of water are used per ton of hay produced. The chemical, which is proprietary, serves to accelerate the drying of the alfalfa by penetrating and disarranging the cutin layer on the stem.

Cutin is a wax, provided by the plant in order to prevent desiccation. The disarrangement of the cutin by chemical action promotes stem drying, so that the drying rate of the stem becomes about the same as the leaf drying rate.

The chemical serves an additional role, in that it contains a mold inhibitor. Past scientific work has shown that the drying rate and the equilibrium moisture content of hay is a function of its history. Any degradation of the surface cells due to fungal hyphae will serve to inhibit drying or conversely, inhibition of fungal growth will enhance drying.

In addition, the accelerated production cycle, with its greater leaf retention, means that there will be some greater statistical variation in moisture content, and greater mold potential, even at nominally correct moisture levels. Hence the advisability of providing some explicit barrier to mold development.

The chemical formulation has been subject to specific examination of its safety as an animal ingestant. Ingredients are limited to those whose safety is widely accepted.

The technical approach which I chose includes a preferential wetting of the alfalfa stems--in fact, after the windrow has been formed, a close examination shows the leaves are almost dry. This is accomplished both chemically and mechanically.

Mechanically, preferential wetting is accomplished by the method of spray application. A push bar, or crop deflector bar, is located on front of the header and about 8-11 inches above the cutting level. The crop is thus bent forward as the cut progresses. From above, a spray is directed on the deflected crop. Due to the geometry of crop deflection, the spray impinges primarily on the stems.

Chemically, preferential wetting is aided by the interfacial surface tension of the chemical solution. Since the leaves are pubescent (covered by fine hairs) and the stems are smooth, surface tension control of preferential wetting is feasible.

It is important that a very high percentage of the alfalfa stems be wetted, and that a substantial proportion of their lengths be wetted by the solution. The choice of spray bar position and pattern assures that this will occur.

It seems desirable to control the spray application automatically with the cutting operation. This is accomplished by driving the spray pump from some portion of the header drive, so that the pump is activated only when the header is engaged.

The chemical solution is stored in a spray tank located on the windrower. A 150-gallon tank will provide enough spray for 10 tons of hay--about an hour's cutting. Refill is usually made from a premixed solution in a nurse tank. The solution is safe to handle and requires only ordinary care.

Operational procedures have been developed to complement the system. These include the following:

Initiate cutting well before daybreak, so that the total of the cutting is completed when morning dew is gone.

2. Cut at a stubble height of 3-5 inches, depending on crop weight.

3 Make the windrow as wide as possible. It is desirable that the windrow width be about one-half the cut width if the crop is heavy.

4. Minimize the raking operations. Invert the windrow or rake when the moisture is about 25%.

5. Avoid going overnight with a raked windrow

6 Bale at a moisture level of about 19.5% for conventional bales, and 16-17% for big bales. The optimum moisture for 6-ton stack is also about 19.5%.

7 Always measure moisture by drying and weighing. Electrical moisture meters show gross errors in this application.

8. Go on measurement, not on "feel."

III. Results of Tests

The commercial production results showed the following:

The time interval between cutting and baling is reduced by more than one-half.

2. The hay which is produced has a soft feel, with exceptional leaf retention and green color. In spite of the soft feel, it remains cool.

3. Large-scale feeding to dairy cattle has shown milk production increases of 1½-3 lbs. per day.

4 The process demands disciplined measurement of moisture and the timing of any raking and baling operations.

The university tests have produced quantitative results. Tables 1 and 2 show the results obtained at the University of Florida, reported at the winter meeting of the Florida Soil and Crop Science Society.

It is apparent from this data that even under the adverse climate conditions, next-day baling was feasible. The bales which were produced showed excellent characteristics in storage. It is also apparent that treated hay baled at the correct moisture

remained at temperatures low enough to preclude molding, while the untreated hay suffered badly.

Similar data have been obtained at the other university sites, but have not yet been organized for public presentation.

TABLE 1

Moisture Comparisons of Untreated Versus Treated Alfalfa Before and After Baling

Date	08/13	08/13		08/14	08/14	08/18	08/28	09/15
Hours after cutting	0	4	R	20	24	120 (5 days)	360 (15 days)	768 (32 days)
Time of day	1230	1630	A	0830	1230	1230	1630	1630
Status	Windrow	Windrow	I	Windrow	Windrow	Bale	Bale	Bale
Moisture % (Untreated)	80	34	N	58	33	34	22	19
Moisture % (Treated)	80	18	.2"	56	20	18	17	12

TABLE 2

Bale Temperature Comparison

Date	08/15	08/16	08/17	08/18	08/19	08/25	09/02	09/07	09/12
Days after baling	1	2	3	4	5	10	17	22	27
Temperature (°F - Untreated)	117	118	124	128	124	114	92	95	92
Temperature (°F - Treated)	99	91	91	91	86	88	86	86	86

Note: Alfalfa Hay cut on 08/13/81 at the University of Florida under adverse weather conditions--high relative humidity, fog, and overnight shower. All hay was baled on 08/14/81.