THE BIG BALE HAY PACKAGE IN CALIFORNIA -- A FEASIBILITY STUDY*

Ray M. Lien
Agricultural Engineer
Purdue University
West Lafayette, Indiana

The big roll bale commonly used in many parts of the United States is not used in the California commercial hay market. One reason is the present systems have been developed over a number of years and consequently all field transport, processing and feeding systems are oriented toward the use of the rectangular bale or cubes. The recently developed big roll bale with its increased handling efficiency and decreased operating costs is favored over the use of the rectangular bale in those livestock systems where hay is grown and fed on the same farm. The big roll bale presently does not fit into the commercial hay market due to its size and density configuration and the non-availability of certain handling, feeding, and processing equipment commensurate with the commercial operation.

INTRODUCTION

California ranked No. 2 in total hay production in the United States in 1973 with a total output of 7,865,000 tons -- the distribution being 6,902,000 tons of alfalfa and the remainder consisting of grain and other hay. About 80% of the alfalfa hay produced was put up in rectangular bales, about 10% cubed and the remaining 10% converted to alfalfa meal and pellets. The latest California Alfalfa Hay Market Summary indicates a 1.7% decrease in hay production in 1974 with slightly greater emphasis on baled hay than on cubes or alfalfa meal and pellets.

The annual alfalfa production for hay producers throughout California ranges from 5 to 7 tons per acre. This production is obtained from as few as 3 cuttings in the cooler northern uplands to 6 and 7 cuttings in the central and lower California valleys. Climatic conditions dictate the moisture content of alfalfa hay for baling should be 17% or lower for the 120-150 lb. three wire bales in order to prevent spoilage.

It is estimated that 85 to 90% of the alfalfa hay produced in California is sold and transported through the commercial hay distribution channels. This hay is transported by truck for distances ranging from 20 to 200 miles. The study on "Energy requirements for agriculture in California" reports the average truck load of alfalfa is 24 tons and is transported 140 round trip miles. Any change in a hay package size will need to be compatible with transportation methods now commonly used and must fall within the specified regulatory measures.

The dairies are the big consumers of alfalfa hay -- approxiamtely 4,300,000 tons in 1973. The dairy enterprise and beef feed lot operations are similar in that they both purchase hay that is transported by truck from a distant hay grower or broker. Their farm processing methods are somewhat different. Most dairies feed hay directly from the bale without further processing whereas, the beef feed lots grind the hay and mix it with the feed. Contacts made with several dairies ranging in size from 200 to 2400 milking cows indicated the dairies feeding baled hay were less mechanized in moving the hay from farm storage to the feeding area than were those dairies feeding cubes, or the feeding operation of the beef feed lots.

OBJECTIVES

To seek answers concerning the possible use of a larger hay package in the commercial market, a feasibility study of large roll bale forage systems in California was initiated by the Agricultural Engineering Department at the University of California, Davis, in late 1974. The objectives of the study were:

---

* Study conducted while on Sabbatical leave at the University of California, Davis, January 1 - July 1, 1975. Assisted by Robert G. Curley and John B. Dobie, Agricultural Engineers, University of California, Davis. Agricultural Engineering Project No. 0234 financed in part by International Harvester Product Research, Agricultural Equipment Division, Chicago, Illinois.

1. To determine the adaptability of the large roll bale to California forage cropping and marketing systems with special emphasis on commercial transport.

2. To determine the optimum dimensions, density and other characteristics of large roll forage bales for their utilization under California conditions.

3. To consider the optimum system for utilization of the large roll forage bale for California conditions and develop a cost comparison with presently used methods.

4. To consider possible uses for the large roll bale in crops other than alfalfa

In December 1974, a questionnaire was sent to 108 forage and livestock farm advisors located in fifty-seven California counties where commercial hay production and/or livestock numbers were of a magnitude to be significant in the study. (See Figure 1) A 65% response was received. Geographically, 81% of the counties responding reported potential or possible use of the big roll bale forage system, although 30% of these felt that the system may be limited. No potential use could be foreseen for the system in 19% of the responding counties. Many respondents were only vaguely familiar with the big bale system and the handling equipment available. The survey also revealed the presence of only four farmer-owned big roll balers in the state of California -- all being located in the northeast section of the state in counties near the Oregon state line.

Following the farm advisors survey, an extensive field investigation was conducted. Studies and observations were made of the whole spectrum of the commercial hay market over many parts of California during the period of January to July 1975. This included contacts with hay producers, coops and hay brokers, hay haulers, transportation supervisors, dairies and feedlots. Cow-calf operations, where the major portion of the hay is grown and fed on the same farm, were also observed. Many persons visited commented that the rectangular bale was not the ideal handling and feeding unit but that nothing better was in existance to replace it.

Adaptability

Concern was expressed in many cases about the magnitude of the alfalfa plant damage and soil compaction caused by the present rectangular bale system. Estimates of the present system are that up to 75% of the surface of the alfalfa fields are affected by wheel tracks during the yearly haying operation. The handling of fewer, larger bales would seem to decrease this percentage, thereby resulting in less plant damage and less soil compaction.

The early part of the study indicated the rectangular bale has many positive aspects in the commercial hay market today.

1 The rectangular baler can operate over a variable type of terrain.

2. The system has a reasonably high output capacity

3. Cost data covering many years of use is available.

4 The bale is in a unit size that is easily adapted to handling multiple units for loading and unloading transport vehicles.

5. Mechanized handling equipment has been developed and is being produced.

The bale size is a convenient measure of feeding quantities

7 Rectangular bales stack and store conveniently.

8. The system has been in use for many years and all transport vehicles, storage sheds, and hay handling equipment is geared toward the use of the rectangular bale.

On the other hand, a few important negative aspects were noted concerning the use of the rectangular bale system.

1 Binding material is gaining in cost

2. Wire type balers perpetuate problems of tramp metal.

3. Bale size does not force complete mechanical handling.

   Many trips are required over the alfalfa field to complete the operation from cutting to road siding resulting in damage to the alfalfa plant and causing soil compaction.

   In certain locations there is an appreciable amount of theft of baled hay from the storage areas.

The size of the rectangular bale unit has not forced complete mechanized handling of the bale from the pick-up point at the roadside to delivery at the end point user. The hay trucker or broker may have sophisticated loading equipment at the point of origin but when the hay reaches the farm, it still is in the unit size where storage conditions may dictate manual unloading. Some trucking companies have been forced to eliminate the baled hay hauling portion of the business having found it difficult to hire good truck drivers due to the physical stress imposed by manually handling the heavy bales.

The size aspect of the rectangular bale also applies to the farm feeding operations where the bales, in many cases, are manually handled for transporting from storage to feeding.

Optimum Bale Characteristics

The big roll balers presently manufactured do not make a bale of the size and density that would provide an acceptable payload (24 to 26 tons) on the allowable size truck-trailer units which are eight feet wide and normally accommodate a load ten feet high from the truck or trailer bed. Common single hay hauling units vary in length from 24 to 30 feet with a combined load length of 50 to 55 feet.

A round bale four feet long by five feet in diameter with a bale density of 15 pounds per cubic foot stacked two tiers wide and two tiers high would provide a payload of 26 tons on a hay hauling unit 55 foot long (4400 cubic foot payload volume). The same size bale would require a bale density of 16.5 pounds per cubic foot for the same load on a 50 foot (4000 cubic foot payload volume) hauling unit. Reducing the payload to 24 tons on a 50 foot long hay hauling unit would require a bale density of 15.3 pounds per cubic foot. The three aforementioned conditions result in bale weights ranging from 1175 lbs. to 1300 lbs. in the four feet by five feet configuration.

Advertising literature of presently manufactured round balers indicate normal bale densities of 10-1/2 to 12 pounds per cubic foot. One company advertises a baler making a four foot long by five foot diameter bale weighing 1000 pounds which would yield a density of 12.7 pounds per cubic ft.

Round balers wrap the twine around the bale at intervals of 6 to 8 inches but do not tie the loose ends. It would seem that hay moved in the commercial market with the densities as indicated and the handling involved would require some type of tieing device to secure the twine around the bale. At any rate, a big roll bale suitable for the commercial hay market must retain its physical characteristics from packaging until feeding.

Optimum System

The optimum system for handling hay in the commercial hay market would be one that is completely mechanized from packaging to the point where the hay is fed to the animal. It is envisioned that this is quite possible with a modified round bale.

A total system concept of the big roll bale in the commercial hay market requires development of machines and equipment not presently available. These include:

1. A round baler that will produce a bale of the characteristics previously described.

A bale collector-stacker capable of self loading and hauling a 6 bale load, and stacking the bales in two rows three tiers high. This machine would collect and roadside the bales. The round bale stacks would be made stable by laying the bales on their sides with the three tier high bales angled slightly toward a tie-tier section of bales stacked periodically four high on end.

3. A boom or crane type device mounted on the truck bed or first trailer that could be used both for loading and unloading the bales of both hauling units. This same boom or crane device may possibly be used for loading and off-loading bales of other hauling units. Other lifting and loading configurations should also be considered.

4. A self loading transport machine with one or two bale capacity which would unpackage and convey the hay into the feed bunks or into additional processing equipment would be required. The transport machine could be equipped with a scale for accurate metering.

A medium horsepower farm tractor equipped with a front end loader and a special type grapple hook or similar device could be used to move the bales at the farm storage site, if required.

A system of this type would completely mechanize the envisioned modified round bale from packaging through storage and transport to feeding.

Observations and studies of the California commercial hay markets indicate the following conditions must be met in order for the big round baler to receive consideration.

1. The economics of its use must be favorable.

2 A total mechanized system concept from baling to feeding must be developed.

3. A bale of suitable size, density, and structural integrity providing the necessary payload based on department of transportation regulations must be produced.

4. Acceptable stacking procedures for round bales stacked several tiers high need to be developed.

5. Weathering losses for round bales stacked outside need to be determined.

6. The alfalfa leaf loss from roll balers must be proven to be no greater than that of the conventional baler.

Other Uses

The greatest interest displayed in the use of the big round bale was in the cow-calf operations in the northern part of California. These operations range in livestock numbers from 100 to 2000 head with the average size herd being somewhere between 200 to 260 head. The main reason for this interest is three-fold.

1. The operators are looking for more efficient methods of labor utilizations in the feeding process.

2. They are looking for a cheaper method to get the hay from the field to storage.

3. Cow-calf ranchers in this area were generally well informed about the big roll system.

Farm labor is difficult to obtain for feeding and for hauling the hay the short distances from the field to on-the-farm storage. Quotes of 18¢ to 25¢ per bale were mentioned for the hay hauling process from field to storage.

The cow-calf operations require about 20 to 25 pounds of hay per day per cow during the 3 to 5 winter months. Thus approximately 1 to 2 tons of processed hay per cow is required each year. The hay is usually grown on the farm or is purchased nearby.

The cow-calf operators in many cases mow and windrow the hay in the pastures following the time the cattle are taken to the upland summer grazing areas. The usual practice is to mow the pastures in early summer and leave the hay in the windrows with the consequent loss of nutrient value. During the fall season, after the cattle return, they are allowed to graze from these windrows.

A demonstration was conducted using the big round bale for preserving the windrowed hay. This operation could lead to the savings of many dollars in hay value for winter feeding in the cow-calf operations by reducing hay nutrient losses.

Sufficient round bale handling equipment is either on the market or in the process of development to take care of the cow-calf enterprises. This market, however, also needs to be approached with a total system concept.

The cow-calf operations were probably the least mechanized of any operation observed. These operations are usually located in the upland areas where the cattle are fed packaged hay only a few months of the year. Baled hay is typically tossed from a pickup truck onto the ground or into feed bunks depending upon the type of operation. The cow-calf operations do not have a high labor demand during the period when the feeding is required, and therefore, less need for a highly efficient system of hay handling.

The larger cow-calf operations have highly efficient feeding systems for cattle in dry lots. Generally speaking, however, the cow-calf operations are not as mechanized and efficient in the feed handling aspect as are the beef feed lots and dairies.

CONCLUSIONS

The following conclusions are offered as a result of the big bale feasibility study

1. Crop damage with conventional bale systems is significant and needs to be reduced

2 The commercial hay producers and haulers' equipment is geared toward the use of the rectangular bale.

3. To change handling systems of present commercial bales an economic advantage would have to be proven due to large equipment investments.

4 The hay haulers would welcome a change in a bale size that would require mechanical handling during the loading and unloading operations providing no major sacrifice was made in payload economics.

5. The dairies have established a system of rationing the feeding quantity required per cow by the number of bales fed, but a mechanical large bale feeding system would be acceptable.

6. A complete commercial hay system based on the big roll bale concept appears to be feasible.

7 A partial theoretical cost analysis indicates support for development considerations of a commercial big roll bale equipment system.

LARGE ROLL BALE SURVEY RESPONSE

DECEMBER, 1974

KEY

X Potential Use

0 Possible or Limited Use

☐ No Potential Use

Figure 1