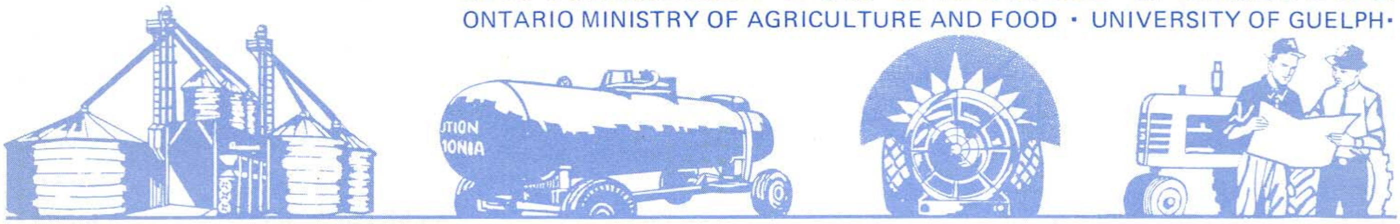
INFORMATION FOR INDUSTRY PERSONNEL
ONTARIO MINISTRY OF AGRICULTURE AND FOOD · UNIVERSITY OF GUELPH ·



Source —
Gary Hutchison
Dept. of Agricultural Economics & Business, University of Guelph
Pat Plue, Agricultural Engineering Services, O.M.A.F.

AGDEX NO. 120/51
Date 1989 June

Understanding the Big Bale Business

The business of packaging hay is going through another major change. Although the square bale business is still alive and well, farmers are continually moving more and more of the hay volume toward the labour saving big bale. The addition of the big bale has created problems. There can be severe losses when stored improperly and there are also more losses when feeding. In order to understand the economics of the big round bale it is necessary to appreciate the amount of material in a bale. This, in turn affects the cost of baling, the value of bales and the losses from weathering.

The Quantity of Material in a Big Bale

The weight of a given bale will vary according to the size of the bale, the moisture content. the type of material, the type of baler and the density of the bale. The following tables will provide the reader with some insight as to the quantity of material in various sized bales of different types of material from soft and hard-core balers.

TABLE 1: Expected Hay Densities (lbs./cu. ft.) for Hay at 18% Moisture Content

	Fixed Chamber (soft centre)	Expanding Chamber (hard core)
Alfalfa	9.5 -- 10.0	11.5 -- 12.0
Mixed	9.0	11.0
Grass	8.0 -- 8.5	10.0 -- 10.5

Note: -- looser bales can be made using accelerated ground speeds vs. pick-up and belt/roller speed.
--- when hay is baled at 55% moisture for haylage, the bale will contain the same amount of dry matter but will weigh more because of the water involved. -- i.e. if a 4' x 5' hard-core bale* at 18% moisture, weighs 750 lbs.. then a similar bale at 55-60% moisture will weigh twice as much, or about 1500 lbs.

* In designating bale size a 4' x 5' bales refers to a bale which is 4' in diameter and 5' long.

TABLE 2: Bale Volumes (cubic feet)

	bale length			
	36"	48"	60"	72"
Bale Diameter (inches)				
36	21.2	28.3	35.3	42.4
48	37.7	50.3	62.8	75.4
60	58.9	78.5	98.2	117.8
72	84.8	113.1	141.4	169.6

Note: – The tables are given in imperial measures to correspond to the marketing of balers in North America.

How To Use These Tables

Table 1 is an estimate of the number of pounds of material in a soft-core versus a hard-core baler for given types of material. For example, a hard-core bale of mixed alfalfa - grass hay will have approximately 11 pounds for each cubic foot of volume.

Table 2 provides the cubic feet in bales of different diameters and lengths. A 5 x 5 (foot) bale will contain 98.2 cubic feet of volume. When the volume is combined with the density table, an estimate of the weight of the bale can be made.

Examples:

- a 5 x 5 hard-core bale of mixed hay will weigh 98.2 x 11 = 1080 pounds.

- a 5 x 4 hard-core bale of mixed hay will weigh 78.5 x 11 = 864 pounds or 80% of the 5 x 5 bale.

- a 6 x 4 hard-core bale of grass hay will weigh 113.1 x 10.5 1188 pounds.

Note: Where possible, a weigh scale is always the preferred method of determining average bale weight.

The following summary is a quick reference on the relative weights of bales assuming the various bale sizes all come from the same baler, with identical density, the same moisture content and the same type of material.

TABLE 3: Relative Quantity of Hay in Varying Diameter Bales

Diameter (feet & inches)	Relative Quantities
6.0	100
5.6	84
5.0	70
4.5	56
4.0	45
3.5	34
3.0	25

Interpretation: At the extremes a six-foot bale has four times as much material as a 3-foot bale of equal length. Likewise a six-foot bale has 2.25 times as much material as a 4 footer (100/45) and 1.43 times the material of a 5-foot bale (100/70). A five-foot bale on the other hand has 1.56 times as much material as a four-footer (70/45) and 25% more than a 4-1/2 foot bale.

How to Use These Tables

These tables can be used to estimate the value of hay and the cost of baling. For example, if hay is selling for $65 per tonne and the bale weight is estimated at 800 lbs., the bale is worth $65 x 800/2,200 = $23.60 all other things being equal. Likewise, if a six-foot diameter bale is selling for $25. a five-foot bale of identical hay from the same baler is only worth 25 x .7 = $17.50. (0.7 comes from 70% value from Table 3) On the other hand, a six-foot diameter bale of 48 inches in length has basically the same amount of material as a five-foot bale six feet long (113.1 vs. 117.8 in Table 2). At least one of the more popular balers has a chamber of 46 inches in width not 48 inches. These tables can still be used to estimate the volume, weight and ultimately the value of bales from chambers other than those set out above. For example, a baler with a 46 inch chamber would have roughly 96% of the material of a 48 inch (46/48 x 100%) chamber all other things being equal. Likewise, if a 5 x 5 bale was selling for $25, a 60 x 46 inch bale would be worth $25 x 46/60 = $19.17.

Baling Costs

Both farmers and custom operators should be aware of the differences in baling costs relative to the quantity of material. The baling costs vary more with the number of bales produced per hour than the amount of material baled. There are many reasons for this. For example, the binding on a 6-foot diameter bale is only twice the binding of a 3-foot bale and yet the quantity baled is 4 times. A five-foot bale has 83% as much binding as a 6-foot bale but only 70% as much material. Likewise, a four-foot bale has 67% as much binding but only 45% as much material as a 6-foot bale.

TABLE 4: Amount of Binding Relative to the Size of Bale

Bale Diameter	Circumference (π × diameter)	Circumference Ratio			Quantity Ratio		
(feet)	(feet)	3'	4'	5'	3'	4'	5'
3	9.42	1.00			1.00		
4	12.56	1.33	1.00		1.80	1.00	
5	15.70	1.66	1.25	1.00	2.78	1.56	1.00
6	18.84	2.00	1.50	1.20	4.00	2.25	1.44

The binding costs per tonne of material are not very significant if only plastic twine is being used. However, an airtight package (i.e. for big bale haylage.)on one six foot bale would be much more economical than the same package on 4 3-foot bales. Similarly, the use of nylon mesh will be much more cost effective for the bigger bales.

The stopping and clutching is basically the same regardless of the size of bale. In other words whether one 6-foot or one 3-foot bale is made wear on the tractor and operator is about the same. Therefore, it obviously costs more to bale a small bale relative to a big bale. For example, if a farmer is justified in paying a custom rate of six dollars for a five-foot bale he/she is justified in paying 113.1/78.5 x $6 = 1.44 x $6 = $8.64 for a six-foot bale from a 48 inch bale chamber based on the quantity of material baled.

The number of bales produced per hour certainly affects the costs per bale. Equipment and operator must equate time and money. An operator baling 2 bales per hour at $6 per bale has more gross income per hour to work with than baling a light crop at 6 bales per hour. Based on the assumption that the binding costs 60 cents per bale and the extra clutching is 20 cents per bale, the returns to tractor, baler, and operator, over and above materials and the extra machinery wear at 12 bales per hour are 12 X $6 - 12 x $.80 = 72.00 - 9.60 = $62.40. If only half as many bales can be baled each hour from a light crop, the return to labour and machinery is only 6 x $6 - 6 x $.80 = $36.00 - $4.80 = $31.20 or obviously one half the rate with a heavier crop. Either too much is being charged for the heavy crop or not enough is being charged for the lighter crop. If the operator required $62.40 for the machinery and the operator, the light crop per bale cost would have to be $62.40/6 + .80 = 10.40 + .80 = $11.20 each. On the other hand, if an operator is satisfied with $31.20 return, the heavier crop should cost $31.20/12 + $.80 per bale equal $2.60 + .80 = $3.40 per bale. Neither figure will be satisfactory to the operator and the customer.

Suppose the return to the operator and his tractor and baler should be $50.00 per. hour plus the binding and extra clutching cost of each bale. Twelve bales per hour should cost $50-00/12 = $4.17 + $.80 = $4.97 or $5 per bale. The lighter crop would cost $50/6 = 8.33 + $.80 = $9.13 or roughly $9 per bale. Competition may not allow an operator to charge $9 per bale. However, the operator would be better off to pass on the baling than to offer his services at less than cost. The decision will be based on the operator's opportunity costs on his/her labour and machinery.

TABLE 5: Baling Costs (Dollars) Based on a Given Return Per Hour to the Operator, Tractor and Baler (assume 80 cents variable cost per bale).

Number of Bales Per Hour	Returns per hour		
	$40	$45	$50
4	10.80	12.05	13.30
5	8.80	9.80	10.80
6	7.47	8.30	9.13
7	6.51	7.23	7.94
8	5.80	6.43	7.05
9	5.24	5.80	6.36
10	4.80	5.30	5.80
11	4.44	4.89	5.35
12	4.13	4.55	4.97
13	3.88	4.26	4.65
14	3.66	4.01	4.37
15	3.47	3.80	4.11

The above figures appear to provide a nice neat and tidy table to guide the custom operator and the customer. Unfortunately there are other considerations that must become a part of the decision-making process. The following is a partial list.

- distance to the job
- size of job
- the terrain
- the type of material
- the binding required depends on the number of moves of each bale.
- some balers do a much nicer job of baling than others
- reliability timeliness of the operator and/or
- reliability of the customer to make prompt payment

Some farmers may look at their feeding and handling equipment and allow these two factors to dictate the size of bale. However, anyone contemplating a long run switch to round bales in quantities over 400. for example, should modify their handling and feeding facilities in order to take advantage of the economies of the larger bales.

Finally, Table 3 can be used to estimate losses due to weathering. For instance, a 61 diameter bale which has 3" of weathered material on its circumference contains the same quantity of usable material as an unweathered bale of 5.5' diameter. Thus, the quantity of spoiled material is 100-84 = 16% of the initial volume! Similarly, if the initial bale diameter was 4' and 3" of weathered material was found, we would have the equivalent of a 3.5' diameter bale. Thus, the loss is calculated as follows: B = 45-34/45 = 25%!