Large round bale silage

Making round bale silage consists of wilting a forage to 50 to 60 percent moisture content, baling it in a round baler, and ensiling it within a plastic cover. This silage making technique can be used as a feed option by any farmer who produces forage, and it does not require a large silo or haylage harvesting equipment.

PROS AND CONS

Round bale silage, like any storage method, has its strengths and weaknesses. As a low-cost storage unit for long-stem grasses or legumes, it benefits the small or part-time farmer in particular. The needed storage capacity can be supplied by round bales when silo capacity is lacking during times of forage surplus. The bales can be placed in convenient locations around the farm to provide small feeding units for planned consumption time. In addition, large round bale silage can provide more precise allocation of forages, based on quality, to different classes of animals than can be achieved with either upright or bunk type silos. However, the storage cost per ton of forage is greater than for a permanent storage structure that will be filled twice each year. Disposal of the used plastic wrap or bag is also an environmental concern.

Another advantage is shortened harvesting time, because the cut crop needs to wilt only a few hours before baling. Anticipated rainstorms or high-humidity conditions are a constant risk when working with hay in Pennsylvania, but are less of a problem with silage. The 50 to 60 percent moisture content at baling reduces leaf loss during harvest, which results in a higher quality protein source than field-cured hay. Ensiling does not, however, improve forage quality. The general adage of "garbage in - garbage out" is certainly true with ensiled forage, regardless of the storage structure.

Making and feeding the silage bales are labor efficient processes. One person can complete the steps involved in making round bale silage if adequate equipment is available. However, without a well-designed feeder, feeding and trampling losses are comparable to or greater than hay losses. Assuring tight bale seals is of utmost importance because uncontrollable air leaks can result in varied feed value, mold growth, and excessive spoilage losses.

TYPE AND MATURITY OF FORAGE

Many different species of forage have been used to make large round bale silage, including alfalfa, red clover, perennial grasses, oats, sorghum-sudangrass hybrids, and mixes of grasses and legumes. All of these forages can make good silage, provided the forage has sufficient fermentable carbohydrates. To optimize carbohydrate levels, forages must be cut at the proper stage of maturity and wilted to 50 to 60 percent moisture content.

To obtain the highest yields of high-quality feed while maintaining a productive stand, forage crops should be cut at the following stages:

Crop	Maturity stage
Alfalfa (established) - first cutting	Mid-bud to early bloom
Alfalfa (established) - later cuttings	Late bud to early bloom
Alfalfa (new seeding) - first cutting	Early bloom
Red clover - first cutting	1/4 to 1/2 bloom
Red clover - later cuttings	1/4 bloom
Perennial grasses - first cutting	Heads emerging from boot
Perennial grasses - later cuttings	5 to 6 weeks after first
Small grain	Early head emergence
Sorghum-sudan hybrid	Height of 3 to 5 feet
Grass-legume mix	Based on legume maturity

STEPS IN MAKING ROUND BALE SILAGE

Mowing with a mower-conditioner is best. The mowed forage is left in the swath long enough for it to wilt to 55-65 percent moisture. Drying periods usually range from two to three hours if mowing is done early in the day, to overnight if mowing is done late in the day.

Baling with a fixed-chamber baler makes uniform sized bales which fit easily into bags or stack neatly when wrapped. Some balers will require modifications such as scrapers to prevent gum buildup on belt rollers, or shields to prevent wrapping of the crop. A slow ground speed helps make tight bales which are less likely to spoil. Net tying and plastic twine are recommended; sisal twine should be avoided because the chemical twine preservatives often degrade the plastic used as a bale wrapper. Inoculants can be added, but usually are not necessary. Hauling the bales to a bagging or wrapping site immediately helps ensure feed quality, as well as bale roundness which is important when wrapping.

Wrapping bales is quicker than bagging, but it requires a bale wrapping machine, which means a capital expenditure you don't have with bagging. Wrapping machines cost around $6,000 to $12,000, depending upon the level of sophistication desired. To justify the machine cost, one should wrap a minimum of 100 bales per year. A recent study revealed that two workers can wrap 25 to 30 bales per hour.

Plastic for wrapping usually is one mil (0.001 inch) thick and comes in rolls which are 5,000 or 6,000 feet long. Each roll will cover 25 to 30 bales. The plastic costs $3 to $4 per bale in 1991 prices and can be used one time only. Each bale requires from 1.5 to 2 pounds of plastic, so ask your supplier about a recycling or rebate option for the used plastic.

Quality plastic has a tackiness agent which is crucial to proper sealing. The plastic is typically stretched 50 to 55 percent in order to get the correct tension. Several years ago, instructions were to wrap each bale rotation with a 25 percent overlap of the plastic, therefore providing each bale with four layers of plastic. Today, four layers are still recommended, a better seal is created when the bale is wrapped with a 50 percent overlap and then wrapped twice. Like bagging, the wrap is *not* airtight but it does restrict enough air exchange that fermentation can take place. Best results are achieved when 100 percent virgin plastic is used, which is warranted for a minimum of one year.

Bagging is trickier than wrapping. After a few bales are made, check the bag fit. Bag at the storage site only, because this area already should be cleared of obstacles and nuisances that puncture the bags. Once the bag is over the bale, push out excess air before sealing. To seal the bag, a strong hand is needed to twist and stretch the bag end while a second hand or a second person ties a knot with rope. Twist tightly and tie once, then bend the twisted plastic back onto itself and tie the two twists together. Polyethylene (PE) plastic film used for these bags is not airtight. In fact, low density PE is four times more permeable by carbon dioxide gas than it is by oxygen gas, allowing the bags to vent excess carbon dioxide gas as fermentation begins.

Patch holes found in a bale bag as soon as possible, because wind causes loose plastic to bellow and provide an air exchange which usually spoils most of the outer layer of the bale. Duct tape and masking tape last about three weeks before they fall off, but bag suppliers have a polyethylene tape which adheres for bag life. Bags are rarely reusable because of minor pinholes.

No research has revealed that any bag color is better than another as far as silage quality is concerned. Black plastic bags have an ultraviolet inhibitor, called carbon black, which limits bag degradation under sunlight. White and green bags will degrade quicker. If a bag is made from quality materials, the supplier should be willing to guarantee it for one year.

Bags cost from $6 to $8 each in 1991 prices. Table 1 compares costs of wrapping versus bagging when 150 and 300 bales are made each year in Pennsylvania. Although the numbers may vary from one region to another, they show some of the factors which must be considered when deciding on a storage method. For comparison, it would cost about $52 and $30 per ton to ensile similar amounts of

Table 1. Comparative costs of wrapping versus bagging for two typical circumstances.

			— 300 bales/year —		—150 bales/year—	
Inputs			Wrap	Bag	Wrap	Bag
Plastic	Price	$/bale	3.50	7.00	3.50	7.00
Labor	No. workers		2	3	2	3
	Bales/hour		25	20	20	16
	Wage	$/hour	6.00	6.00	6.00	6.00
Machine	Price	$	6,000	5,000	6,000	2,000
	Interest	%/year	10	10	10	10
	Life	Bales	4,000	5,000	4,000	5,000
	Salvage value	%	20	20	20	20
Size	Bale weight	lb DM	600	600	600	600
Results						
Plastic cost		$/bale	3.50	7.00	3.50	7.00
		$/ton	11.67	23.33	11.67	23.33
Labor cost		$/bale	0.48	0.90	0.60	1.13
		$/ton	1.60	3.00	2.00	3.75
Machine cost		$/year	787.23	602.66	641.03	206.96
		$/bale	2.62	2.01	4.27	1.38
		$/ton	8.75	6.70	14.25	4.60
Total cost		**$/bale**	**6.60**	**9.91**	**8.37**	**9.50**
		$/ton DM	**22.01**	**33.03**	**27.91**	**31.68**

Source: D.R. Buckmaster, 1991. unpublished data.

forage (150 and 300 bales, respectively), in long tube-type bags. The cost to ensile the equivalent of 300 bales in a concrete stave silo is over $42 per ton if the silo is filled only once and $21 per ton if the silo is filled twice each year.

BALE HANDLING EQUIPMENT

There are numerous bale handling devices to move or transport the bagged or wrapped bales, with new ones being introduced regularly from other countries. Most seem to have the following design characteristics.

1. Spears, either mounted on a front-end loader or on a three-point hitch
2. Twin moveable forks with rollers which slide under and cradle the bale
3. Disks which clamp and squeeze the bale while lifting
4. Grapples with overhead arms
5. Trailer mounted sleds which slide under bales

Regardless of the design, each requires at least a 50 hp tractor in order to safely move the bales.

BALE STORAGE

The storage site will give better results if stubble and sharp objects are cleared. Some people lay an old piece of plastic on the ground prior to placing the bales. Spray the perimeter of the stack to kill weeds which harbor insects and rodents. Do *not* cover the bales with an extra layer of plastic because it makes an ideal nesting site for rodents. Rodents can chew through the plastic wrap or bag and greatly increase storage losses. Find a shady area, preferably on a north facing slope, to avoid temperature fluctuations which can degrade both the silage as well as the plastic.

To increase bale density in storage, consider stacking the bales as follows:

1. Above 75 percent moisture content, use a single-layer stack.
2. Between 65 and 75 percent moisture, use a double-layer stack, pyramid fashion.
3. Below 65 percent moisture content, stack up to three layers high, pyramid fashion.

BALE FEEDING

Feeding round bales of silage is similar to feeding large round bales of hay when conventional bale feeding rings can be used. With the high investment for wrapping bales, it is essential to control feeding losses. Some studies have shown up to 50 percent loss when large round silage bales are simply unrolled on the ground. This loss can be reduced to less than 10 percent by using a simple ring feeder. Mobile feed carts, especially designed for unrolling or grinding large bales within narrow barn alleys, are now available in the United States. Tub grinders can be used, but plugging of the grinder with the large bales of silage may be a concern.

The feed quality of large round bale silage, especially those bales with a high proportion of legumes, may cause overfeeding to some classes of animals. Consider using the bales with high proportion of legume for classes of animals that require high quality forage, and restricting the amount of bales available at any time.

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FACTSHEET

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MAINTAINING QUALITY IN LARGE BALE SILAGE

P. Sullivan and **J. McKinlay**

Large bale silage has become popular in Ontario as an option for storing excellent quality forage. By making silage, a farmer can be more aggressive and consistent in cutting schedules as it reduces the weather risk factor. A few farmers use this as their main storage system, but it is more commonly a flexible second system of storage when silos are full and the weather doesn't permit drying. It produces a long stem haylage which is very acceptable to all types of ruminants.

The system makes use of equipment such as large round balers which are readily available. Baleage may be fed using the same equipment as dry, large bales. This provides flexibility, to make as little or as much large bale silage as the weather dictates. Also, baling requires less horsepower than chopping haylage. The front tires of the tractor carry not only the extra weight of the wet bales but more of the tractor weight is transferred to them as well. This reduces traction. Heavier equipment and four wheel drive tractors may be required when handling these heavier bales.

The cost and the disposal of the plastic coverings have been a major concern. Cost is rationalized by considering the higher protein and energy value of the stored forage and the importance of the storage itself. Reduced harvesting losses, which improve yields, and the higher quality of the whole forage crop as the harvest is moved ahead, should be considered when determining the cost benefit of the system. Presently, landfills are still accepting the used plastic but projects looking at reuse of the plastics are underway.

Mold development was discovered this past spring when round bale silage was kept over the winter to be fed in the spring. This has challenged us to consider the reasons for this deterioration. There is less or incomplete fermentation resulting in a higher pH, or less acidic environment, and a more unstable silage than conventional haylage. Maintaining an airtight storage is also more difficult with this system. It is very important to carefully manage the harvest, storage and feeding of round bale silage to provide good, quality feed.

SILAGE MAKING PROCESS

To appreciate the factors contributing to quality in round bale silage, an understanding of the silage making process is necessary. The ensiling process results in the acidification of forage material as a result of fermentation in the absence of oxygen.

There are two main phases in the ensiling process. The first is an aerobic phase. Oxygen is consumed by living plant material through the process of respiration. Plant enzymes and microbes consume oxygen and burn up plant water soluble carbohydrates (sugars) to produce carbon dioxide and heat. The idea is to minimize the time when water soluble carbohydrates are being consumed. The longer the period of aerobic activity, the more heat is produced which will raise temperatures and increase the risk of heat damage.

The second phase is initiated when all the oxygen is used up. Anaerobic bacteria will begin to multiply rapidly and the fermentation process starts. Ideally lactobacilli species, which produce lactic acid using the water-soluble carbohydrates as an energy source, will predominate. The lactic acid will lower the pH of the silage. Fermentation stops after 2 to 4 weeks when the pH becomes so low that all microbial growth is inhibited.

LARGE BALE VS. CHOPPED SILAGE

Large bale silage is not chopped like conventional silage. It is, therefore, more difficult to exclude oxygen and obtain a well packed, high density package. Soluble sugars in the plant, which are used during fermentation, are less available and are released slower. Lactic acid bacteria that reduce pH in fermentation are less active, slowing fermentation. The final pH of large bale silage is usually higher than chopped silage and may be above a stable pH level. It is clear that problems may arise considering the challenges to fermentation of round bale silage. In practice, many farmers are successfully storing and feeding good quality material with this system. These farmers recognize the importance of crop maturity, moisture content, bale density, speed of storing, etc. that all come together to influence the quality of round bale silage.

MOISTURE CONTENT

The moisture content of silage at storage is one of the more important factors affecting quality. Large bale silage can be stored at moisture levels ranging from 40% to 60%. At either end of the range, the risk of storage problems increases. Therefore, harvest should be geared to wilt material to an average of 50% moisture.

Many farmers prefer to harvest round bale silage on the "dry" side which may be as low as 30% moisture. This exact moisture is difficult to establish at times because moisture determination on the farm is sometimes more qualitative than absolute. Drier forage makes handling bales easier, especially where loader equipment is small. The main problem is to be able to exclude the oxygen. Dry silage contains more oxygen that must be used up in fermentation. It is extremely important to have tight bales made with a variable chamber baler when moisture levels approach 40%. It is difficult to make tight bales with mature forage because the coarse material won't pack but it is safer to wilt more vegetative alfalfa and grass to drier moisture levels. If the material is not well packed, more heat is produced from prolonged respiration. Heat damage may increase dry matter losses and bind protein, lowering the feed quality.

Extended wilting of the forage increases the risk of harvest losses. If the weather forecast is predicting rain, silage made on the wet side will reduce weather losses. Round bale silage should be stored without rain damage.

Silage stored too wet will have strong smelling butyric acid rather than lactic acid formation. Butyric acid may be produced with moisture levels above 70%. Clostridial type micro-organisms may also grow in this situation and reduce the quality of the silage. Bales with higher moisture content are more likely to freeze or have more effluent that collects at the bottom of the silage bags. Problems with frozen large bales have been reported. These problems are more apt to occur as moisture levels increase above 50% and during extremely cold winters.

Moisture levels from 45% to 55% offer the best storage for crops harvested for silage. The moisture in the silage should come mostly from the plant. Surface moisture from dew or rain doesn't appear to provide sufficient wetting for fermentation. Large bale silage from forage originally intended for hay that had been rained upon or that was just too tough to dry bale often will not store well. Large bale silage will salvage this type of forage but the product may lack the high quality expected.

SPECIES AND MATURITY

Species and maturity of the forage affect silage fermentation. Early flowering legumes and vegetative grasses contain adequate sugars for fermentation by bacteria. Protein and energy values for livestock are optimal at this stage. Our concepts of quality forage will produce the best material for fermentation.

Grasses are easier to ferment than alfalfa and red clover as they contain a higher sugar content than the legumes; in fact, close to twice the amount. Mature legumes may lack sufficient sugar content for good fermentation. Wilting concentrates the sugars in the plant so that a minimum content is present to complete fermentation.

These factors explain some of the reasons why it is more difficult to make silage with legumes than grasses. In second and third cuts, where regrowth is made up mostly of alfalfa, more attention must be made to moisture levels and stage of cutting. This material is more difficult to ferment. If the alfalfa gets too mature and coarse, it may not pack in the bale, letting more oxygen in, which must be used up in fermentation. Stems may poke holes in the plastic letting more oxygen in, allowing mold growth, especially in warm weather.

BALING AND HANDLING

The key to good large bale silage is the exclusion of oxygen quickly and completely. Start with a very compact bale to reduce air pockets in the bale. Tight bales are made by reducing the tractor speed and picking up hay directly from the windrow that hasn't been raked. If raking is required to allow faster drying, try to maintain a wide windrow. Hard core balers are preferred. Both roller and belt type balers can be used. Bale density should be in the range of 12 lb./ft^3. This equates to a weight of 1200 pound in a typical 4'x 4' round bale at 50% moisture. Plastic twine is recommended for tying bales as the oil based preservative in sisal twine will degrade plastic.

Bales should be moved to the storage area immediately. If left too long they will begin to heat and lose feed value. The sun may evaporate moisture on the outside of the bale making stems brittle. Bales, especially higher moisture bales, lose shape making them more difficult to wrap. Storage should be complete 6 hours after baling and not later than 12 hours.

PLASTIC STORAGE TYPE

The trend in storage systems is towards using stretch wrap on individual bales or continuous line wrappers. Polyethylene tubes are still quite widely used but many are using tubes of stretch plastic. Systems that minimise oxygen re-entry at feeding will reduce silage deterioration.

The major suppliers of plastic wrap will guarantee plastic for up to one year. Properties of plastic include ultra-violet light inhibitors, stretch, puncture resistance and stickiness. Cheaper plastic often is of reduced quality. Most manufacturers recommend at least four layers of plastic with up to six layers for storage up to a year.

Large bale silage may be stored in bags, tubes or stacks. The oxygen present within any of these "containers" is not sufficient to cause excess respiration. If the oxygen can be kept out successfully throughout the storage time, good quality, large bale silage can be made by any of these methods.

STORAGE TIME AND LOCATION

The longer the time in storage the higher the risk of silage deterioration. Large bale silage which is fed out in the fall or winter has generally not been a problem. Cool temperatures work in favour of preservation, keeping microbial activity limited. When temperatures start to increase in late March, molds that were in the silage at low levels may develop into a problem. If fermentation hasn't been complete, spoilage will be more severe.

Farmers have observed fall silage put up in late summer or early fall does not change colour or have any acid smell. This indicates fermentation either did not take place or was very limited. Cooler temperatures and lower numbers of bacteria may be responsible. It is possible fermentation will start again as temperatures warm up in the spring, but this assumes oxygen has not penetrated over winter. This silage is best fed out during the fall and winter to avoid spoilage.

Plastic will attract rodents and just about any other animal capable of putting holes in plastic. The storage area should be clean of vegetation as much as possible, to prevent cover for rodent movement and be protected from other animals.

MOLD DEVELOPMENT

Secondary mold growth may take place as round bale silage is removed from the tubes. If the silage has not properly fermented or contains high populations of yeast and/or mold, oxygen entering the tubes will quickly deteriorate the silage. The implications of oxygen breakdown are important with round bale silage systems using tubes because oxygen may enter the tube as soon as it is opened. Slow feed out through the spring and summer may cause problems. Bales should be fed within one week in the summer, two weeks in the fall and early spring, and four weeks during the winter after opening the tube or storage structure.

Livestock will usually still consume moldy material unless there are too many spores which cause lung irritations. Humans can also be affected by these spores which can lodge within the lungs. The acids produced by fermentation are volatile and thus may migrate from the bale if air enters or may also be leached with moisture migration. This leaves areas where molds may establish.

A white mold or yeast is very common. It produces a large spore which will not irritate lung tissue or cause feed refusal. Other molds which may occur are aspargillus, a grey/blue mold, which may aggravate allergies or abortions in cattle, and fusarium, a red or pink mold which can produce vomitoxin, T2 and other toxins that cause feed refusal, vomiting and estrogen production in livestock. The spores produced by the molds usually cause the most damage. White mold is not a problem but the other coloured molds should be regarded with care. The acids produced by fermentation inhibit mold growth. Fusarium grows at 40 – 60 degrees F; but Aspergilllus and Penicillin grow at 65 – 95 degrees F. This silage would be just warm to the touch. As outside temperatures rise, the temperature of the material will rise into these ranges.

Manure should not be applied to the forage stand before harvest as this introduces undesirable bacteria to the forage which may stimulate mold growth. Raking seems to make the problem worse. Rain during wilting may splash soil borne bacteria and mold onto the forage. Manure contamination will spoil a pocket of the bale but not necessarily the entire bale unless other problems exist.

SUMMARY

We recognize that baleage does not reach as low a pH as chopped haylage. This means that greater emphasis must be put on good silage making processes, especially the exclusion of oxygen. The length of storage time and how long the bales are exposed to oxygen before feed out, must be adjusted to weather conditions. In general, successful use of baleage will involve:

1. Baling a good quality forage within 40% – 60% moisture content in a very compact, even bale.

2. Avoid contamination by manure use or from soil borne bacteria splashed up with rains or by raking.

3. Store the bales quickly excluding the oxygen as soon as possible. Monitor bales to maintain a continuous seal.

4. Size the storage structure to allow efficient, quick feed out.

5. Use good quality plastic to produce a sealed environment.

Weather conditions are the prime reason that most people try the round bale silage system. The quality of the material produced, the use of existing equipment and the ability of scheduling harvesting operations to reduce the weather risk have increased the popularity of the system. It offers flexibility and the ability to store forage quickly if required. These reasons will increase the use of round bale silage in the future. It will be fed in more operations for longer periods of the year. Greater attention to the silage making process will be needed to maintain the quality of the feed with these increased demands.

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Factsheet

RECYCLING FARM PLASTIC FILMS

Stephen P. Clarke, P.Eng., Agricultural Engineer

PLASTICULTURE, THE USE OF PLASTIC IN AGRICULTURE

Plastic is an important new tool in agriculture. It is improving productivity, shortening the growing season and facilitating crop cultivation in non-traditional growing areas. It is also providing new storage systems for forages and grain crops.

This Factsheet will deal with plastic films as they apply to forages and grains.

In 1991, it was estimated that 2000 tonnes (4.4 million lbs) of plastic films were used for the storage of Canadian forages and grains. This is approximately 8% of the 24,000 tonnes (53 million lbs) of plastic film used in the agricultural and construction sectors. To keep this in perspective, it was only 1.2% of the total plastic film used in Canada in 1991.

STORAGE OF FORAGES AND GRAIN

Traditional storages for forages and grain have been made from steel, wood, and concrete. The use of plastic films will continue to grow because of:

- the low capital cost;
- the flexible storage options;
- by using plastic film liners, the life of existing storages is extended;
- the marketing of crops stored in plastic film packages.

WHAT CAN YOU DO WITH USED PLASTIC FILMS ?

There are five main options for farmers:

- reuse them for other purposes;
- recycle them;
- bury them;
- send them to a land fill;
- use them as a fuel source.

REUSE THE PLASTIC FILM FOR OTHER PURPOSES

Currently, plastic film (wrap) has no widespread secondary use on the farm. However, one possibility would be in pillows for free stalls. Current materials for pillows include straw and ground-up rubber tires.

Haylage bags can be reused two to three times if you are careful with them. Plastic agricultural grade film from bags, tubes and sheets can be reused for covering piles of wood and hay, machinery, and for protective liners for horizontal silos. The amount of reuse will depend on the severity of tears and holes in the plastic.

Recreational use of plastic film includes water slides, toboggans, kids' forts plus 100 other uses your kids will come up with. Allow your children to have fun with plastics, *but make sure what they are planning is safe.*

RECYCLING OF PLASTIC FILMS

Recycling means moving plastic from the agricultural waste stream back into the manufacturing process. To make recycling a reality, one must have a system or infrastructure in place. The following are the basic components of any such system:

- Collecting;
- Sorting;
- Reprocessing;
- Marketing.

COLLECTING

For recycling to be effective, one must collect a lot of material, from many farms. However, used plastic film is bulky and cannot be transported very effectively.

To reduce transport cost for this bulky material the farmer can use a farm-type small square baler that uses tine forks for cross feeding into the baling chamber to compact the plastic on the farm. (Figures 1 and 2) Feed the plastic into the baler by spreading the plastic into a windrow and driving the baler into the plastic. Make windrows approximately 1 m x 0.6 m deep (3 feet by 2 feet high). **DO NOT HAND FEED PLASTIC INTO BALER ! This could cause serious injuries if feet or hands become tangled in the plastic .** Large round balers can

also be used, however the resulting size and shape of bale is too hard to handle. One may also have plastic compacted at a commercial compactor (Figure 3). The resulting compacted volume could be reduced to about 1/6th of the original bulky volume (Figure 4).

Figure 1. Windrow of plastic being baled.

Figure 2. Small square bale of plastic, and plastic windrows in background (bale 2.5' long, weight 35 to 45 pounds).

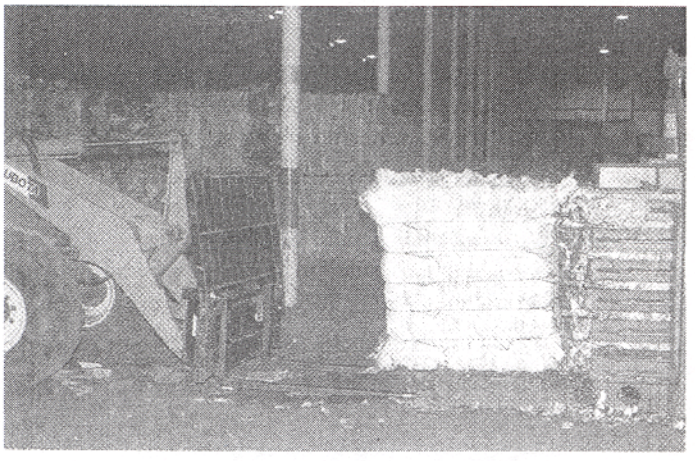

Figure 3. Compacted large bale of plastic (bale 40" x 48" x 48", weight 1500 pounds).

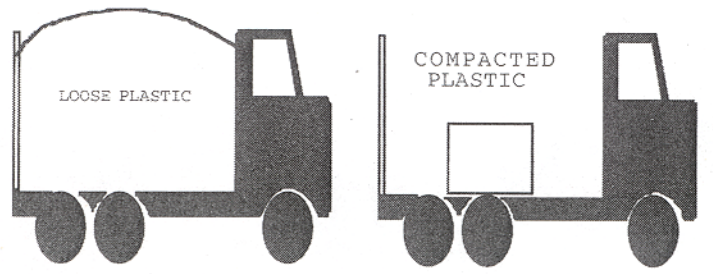

Figure 4. Compaction reduces plastic film bulk by about 1/6th for easier handling and reduced transportation costs.

SORTING

Agricultural plastic film is mainly low density polyethylene. Sorting of this material is needed because there are different plastic products and additives. For example, plastic wrap is 0.9 to 1 mil thick and has tacifiers (glue) compared to tube plastic which is 4 to 10 mil thick with no tacifiers.

REPROCESSING

Agricultural plastic films must be cleaned before being converted into pellets for film or formed into moulded products like plastic lumber and fence posts. Incoming plastics must be inspected for contamination and are accepted or rejected depending on the level of contamination. **Contamination** includes dirt, sand, stones, grease, vegetation , water, other types of plastic, glue, tape and ultraviolet (UV) light degradation. If the film has lost its flexibility and is crinkly, it has serious ultraviolet light damage. UV damage can severely limit the recyclability of agricultural plastic film.

Plastic films are then chopped in a grinder, washed to remove contaminates, then fed into an extruder where heat and pressure melt the plastics. The molten plastic is extruded into fine strands, then cooled and chopped into pellets. These pellets are used by manufacturers to make new plastic film products.

Some plastic film is chopped then melted and formed directly into moulded products.

MARKETING:

Recycled Film

For agriculture, plastic films could be recycled back into plastic film. This is the best option since there is no need to develop a market for the recycled plastic.

Plastic Moulded Products

There are several options for molded products such as: landscape timbers, fencing, planking for farm pens, roadside posts, benches, picnic tables and pallets (Figure 5) . All these options require a marketing plan for selling the new products.

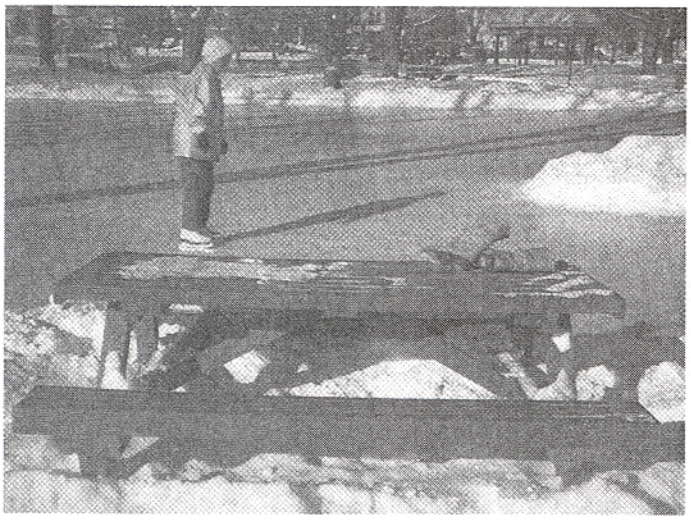

Figure 5. Plastic picnic table (made from plastic lumber).

BURY PLASTICS ON FARM

On farm burial of your own clean plastic film (agricultural waste) is an option. However, **this method is not recommended** since it would be hard to recover the material in the future and seepage of contamination into the groundwater may occur if crop matter is trapped in the plastic.

DISPOSAL OF PLASTIC TO LAND FILLS

Land fills are the most common method of handling municipal solid waste and agricultural film waste worldwide.

From a farmer's point of view, the problems with this option are that:

- landfills are filling up, resulting in less sites available.
- tipping fees range from $80 to $160 per ton
- some municipal landfills may not accept agricultural plastic film waste

USING PLASTIC AS A FUEL SOURCE

Energy recovery is another option that other countries have available for plastic films and for solid wastes. In the U.S. there are 136 energy recovery plants with another 100 plants planned by the year 2000. In Germany, energy recovery is gaining interest as a waste management option. Table 1 lists the energy values for various materials.

Currently, energy recovery is not an option for agricultural plastics in Ontario. However, it may be possible to ship the agricultural plastics to the United States for energy recovery, recognizing there would be a substantial cost in transportation and possible tipping fees.

While energy recovery of solid wastes can reduce volume by 95%, plants require high-temperature burning and pollution control equipment to control air pollutants.

The critical considerations for energy recovery, are the cost of collection, transportation, reprocessing and pollution control.

Table 1: Energy Values of Various Materials

Material	Btu/pound
Agricultural plastic film -wrap,bags, -tubes,& sheets	18,500-19,500
Wood	7,000-7,500
Newspaper	8,000
Fuel Oil	20,500

CURRENT AND FUTURE RECYCLING

The Ontario Ministry of Agriculture, Food, and Rural Affairs has been involved in test projects and pilot collection days with recyclers to work out the problems of cleaning plastic film and possible end use products. With fine tuning, 97% recovery of plastic films into pellets for remanufacturing is possible. These pellets could then be used for making recycled film in a 50 /50 blend with virgin pellets, garbage bags, ground cover sheets, luggage, weather stripping, etc .

Preliminary results indicate that during processing, stretch wrap curls up on itself, is hard to wash, water and dirt is trapped, and extruding filter screens tend to plug up. These results indicate that process adaptations will be needed to make agriculture plastic film into pellets or flakes for remanufacturing.

The results of using agriculture plastic film to manufacture plastic lumber is very promising. Some problems are: the material being too wet and dirty too handle, and brown stripes caused by the burning of silage and haylage residues in the plastic. Modification of the process to handle wet material by adding a drier or collecting only dry plastic and using darker colouring may solve these problems.

SUMMARY

The major problems associated with agricultural film are:

- Inability to keep the material clean;
- Ultraviolet degradation;
- High cost of collection and sorting;
- Lack of reliable end use market.

Efforts are under way to collect and recycle agricultural plastic films throughout the world. These problems will be solved in the near future. **Currently, the best recommendation for Ontario farmers is to store the plastic film for future off farm recycling.**

Steps in Off-Farm Recycling:

- Once the plastic film is removed, shake it to get contaminants off (dirt, haylage, water, ice, etc.). Separate strings from the plastic.
- Store plastic films indoors immediately. This will keep it from further contamination and sunlight. Some farmers are storing plastic in hay wagons inside machinery sheds.
- Keep plastic clean and dry.
- Bale or compact into small square bales for easier handling, storing and transporting. Note: Bale only with plastic string, not jute.
- Send to pilot recycling project in baled or loose form.
- Store for future full scale recycling program.

NOTE: If more than **5% of the weight is contaminants, the plastic film will NOT BE ACCEPTED for recycling.**

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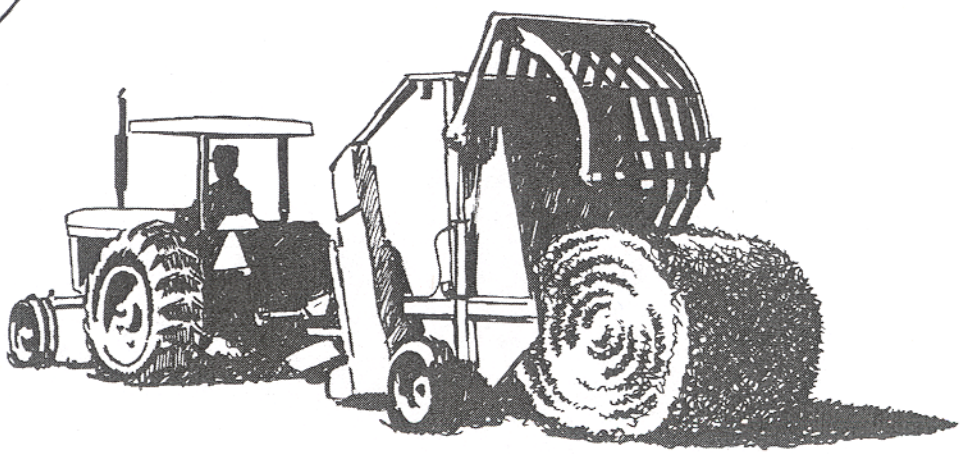

BIG BALE SAFETY

Introduction

Much of Ontario's hay crop is now harvested as large bales. Adoption of big package haying systems has been very rapid, largely because of the major labour savings it provides.

Along with the big bale benefits have come a number of hazards. The equipment used for large bale formation and handling harbours familiar dangers that are associated with all farm machinery. Round balers do feature some unique hazards, and the horsepower involved is usually greater than was required with more traditional, small, square baling systems.

However, the biggest risk — and the one responsible for most of the serious injuries and deaths – is the physical nature of the balers themselves. A compact package of hay or straw weighing from 500 pounds to 1.5 tons (225 kg – 1300 kg) definitely poses some threat to human life and limb at every stage of handling! And because some bales are round, they can roll relatively freely and will gain momentum if the path of travel is downhill.

Equipment manuals should be part of every farm's safety program.

Knowledge is crucial

It is every farmer's responsibility to know the specific requirements, precautions and hazards associated with a particular operation. The manual that is provided with every piece of equipment is the primary source of information on safe, efficient operation. Anyone who runs the machinery should review this material. It is the responsibility of the farm owner or manager to make sure that all employees are well trained in the operation of equipment they will be using.

Advance preparation makes safety sense

Comprehensive maintenance in advance of the major use season can minimize downtime in the field. In addition to improving harvest efficiency, this pre-season preparation may also prevent an accident.

Following is a checklist of procedures which can help detect potential hazards and improve the efficiency of your baler:

- Clean the baler thoroughly to remove crop residues, mouse nests, and other debris. Lubricate according to manufacturer's specs.
- Check for loose or missing nuts, screws, guards, or damaged pickup teeth. Replace missing guards and shields.
- Inspect all belts and chains for evidence of wear or breakage. Belt tension should be matched to prevent slippage, which can cause plugging and damage due to heat buildup. Before replacing a belt or chain, consult the manual for instructions on securing the upper chain or removing load from the belt tension springs.
- Hydraulic hoses should be clean, in good repair and hooked up correctly. Check the twine feeding and cutting mechanisms for proper operation. Also check the slip clutch, roll scraper, and rear gate latch to make sure they are adjusted and functioning according to the manufacturer's recommendations.
- Check lights, reflectors and SMV. Properly operating fire extinguishers should be mounted on both tractor and baler.

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Baler Operation

Operators must have in-depth knowledge of the tractor and baler they are using. It is important to understand how all components and systems are activated on both machines.

- All protective devices should be in place and securely fastened.
- Before starting equipment, check for broken, missing, or damaged parts. Check the condition of tires. Inspect the hydraulic system, using a scrap of wood or cardboard (not your hand!) to detect leaks. Make all necessary repairs before heading for the field.
- Dry crop materials are flammable. Remove trash from behind shields, covers and from around machinery components.
- Lubricate according to directions in manufacturer's manuals.
- Check and adjust components in accordance with instructions in the manual.

Never attempt to clean, lubricate, or adjust the baler unless the tractor engine is turned off, the PTO disengaged, and the ignition key removed.

Walk around the equipment before starting. Check that the rear gate is securely closed. Make sure there is no one in the vicinity. Let others know you are starting up, and don't do so until everyone is clear of the danger area.

Remember – this is a *one-person* operation! Never allow anyone to ride with you on either the tractor or the baler.

Preparing to bale

Most farmers are familiar with hazards in and around their own fields. Extra caution is needed on slopes, around ditches, or near overhead power lines which could be a hazard when raising the baler's rear gate. If someone else will be operating the baler, make sure that they are thoroughly familiar with the hazards.

The pickup should be adjusted to provide adequate ground clearance. If tines contact the ground, the operator could be showered with earth and stones, and the baler won't feed properly. Engage PTO while the equipment is stationary and look and listen for any signs of trouble. Cycle all baler hydraulic systems to assure proper functioning. Check twine feeding and cutting mechanism for proper operation.

Obviously, the material to be harvested must be in suitable condition for baling (20 percent moisture or less). Excessive plugging is likely if the crop is wet.

Ground speed should be matched to crop conditions and windrow size. Keep the pickup high enough to aggressively deliver crop into the baler inlet. If the machine is equipped with feed rolls, maintain recommended clearance and pressure setting. Operator's manuals provide information on correct adjustments, operating procedures for various crops and conditions, etc.

Never try to unplug, clean out or adjust a baler while it is operating. Severe injury or death could be the result. Wait until *all* machine motion has stopped before approaching the baler.

Don't try to feed material into a machine by hand – the hay will be taken in faster than you can let go!

Refer to the operator's manual for bale tying instructions. Resist the temptation to produce oversized bales, which can make bale discharge difficult or damage components.

Safe ejection

Correct procedure for discharging bales is described in operator's manuals. It is important to always keep in mind the fact that round bales can roll downhill! Serious injury and/or extensive property damage could result from careless ejection. Whenever possible, discharge bales on flat, level ground. No one should be near the rear of the baler at time of ejection.

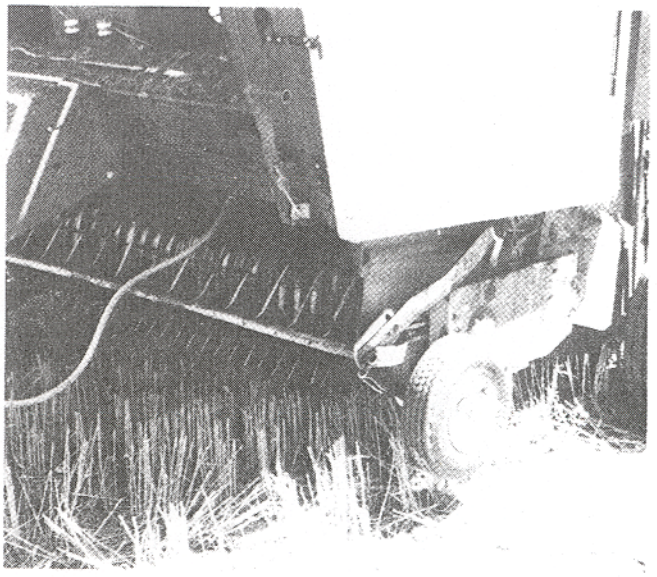
If it is necessary to open the tailgate for manual bale removal or unplugging, shift the tractor to neutral or park, lock the brakes, and disengage the PTO. Raise the tailgate hydraulically, lock it in place, then shut off the tractor engine and remove the ignition key.

Fire precautions

If a fire starts in the baler, pull into a level, open area and eject the bale. Drive clear of the fire area, call for help if possible, then use your extinguisher to bring the fire under control.

Safe transport

Be sure to obey all applicable traffic regulations when travelling on public roads. Lock brake pedals together and use safety chains. The baler should be equipped with required lights, reflectors and a clearly visible SMV emblem.

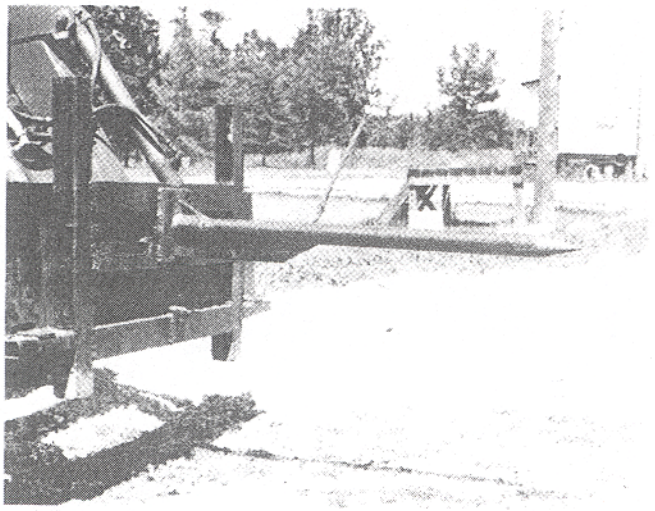


A well maintained baler will minimize breakdowns.

Large bale handling hazards

Serious accidents associated with large bale systems seem to be happening during the handling of the big hay packages.

A number of operators have been seriously injured when improperly secured bales rolled down the arms of front-end tractor loaders. It is strongly recommended that tractors used to handle the big bales be equipped with 4-post rollover protective structures (ROPS), if available for your model of tractor.



Front end loaders must be equipped with proper restraining devices for handling large bales, such as this spear.

However, we shouldn't be relying on ROPS to cushion the blow, and bales shouldn't be moving down loader arms to begin with! A loader should be equipped with a spear or grapple that is specifically designed for handling the size of a large bale that is being produced on-farm. Most importantly, the loader should incorporate a restraining device that will prevent a bale that has come loose from sliding backward.

The loader tractor must be large enough and equipped with sufficient counterweight to handle bales safely. Set wheels at maximum width to increase stability.

Try to avoid steep slopes and rough terrain when conveying bales with the loader. If it is impossible to avoid sloping land, approach bales from the downhill side.

As with any loader operation, avoid sudden starts, stops or changes of direction. Always keep the bale as low as possible for maximum stability. A one ton bale puts the centre of gravity at a precarious level when a loader is raised high. The risk of a bale breaking free is also greater when the loader is raised. Be extremely cautious, and travel only at low speed.

Insist that other workers and bystanders stay well clear of bale handling operations.

Use good judgement when stacking bales in storage. High stacks mean more efficient use of available space, but subsequent removal could be very hazardous.

If bales are to be handled with a 3-point hitch attachment, the tractor must have sufficient front counterweight for stability and safe handling. Practice extreme caution when backing up to a bale. Keep everyone away from the bale and the forks.

Transport considerations

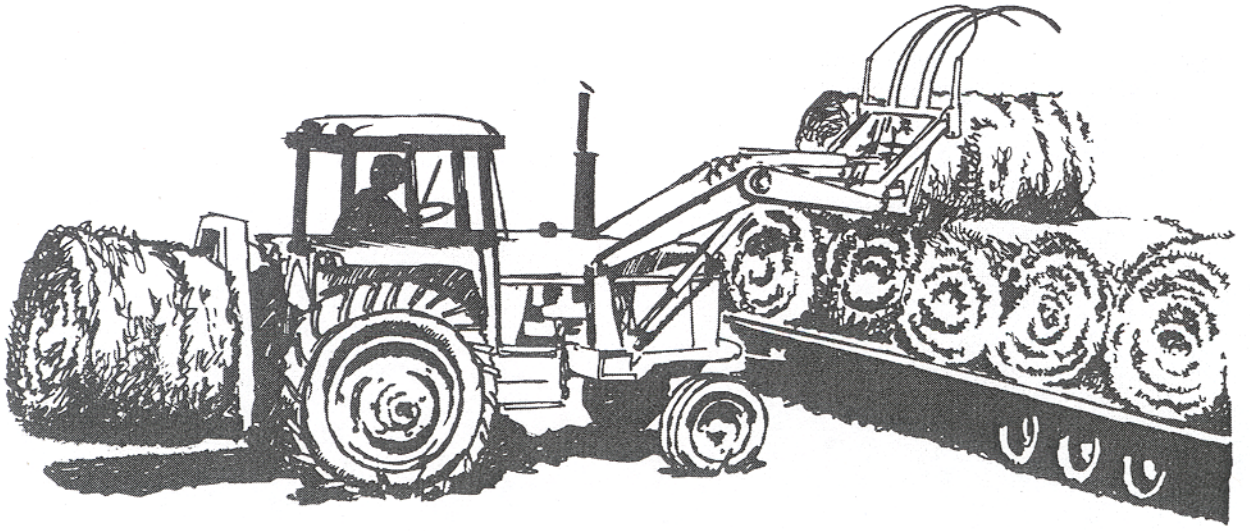
A tremendous variety of wagons, truck frames, etc. have been developed for conveying loads of large bales. Some of these are quite sophisticated, with provision for automated loading and unloading.

Such purpose-designed equipment is safer for transporting round bales. However, we recognize that many farmers will continue to load their big bales on flatbed wagons that were originally built for conventional square bales. If the majority of a farm's harvest is likely to be in the form of large round bales, the owner should consider replacing at least one flat rack with a platform designed to carry round bales. Make sure that the round bale platform won't encourage the building of loads that exceed capacity of the running gear.

It is very important for large bales to be well secured on a flat rack. They should be tied down if the load is to be transported on a public roadway. An innocent bystander was killed by round bales that jolted loose from a flat rack at the top of a hill on a township road.

Following are some additional pointers for transporting loads of large round bales:

- The load being pulled should be no heavier than the pulling unit.
- Inspect the transporting unit before going on the roadway.
- Take advantage of 'engine braking.' Use the same gear going down a hill as you would going up. Keep in mind that most tractors only have two wheel brakes.
- Wagons used to haul bales should be of sufficient width and have end racks to prevent bales from moving off either end during transport.
- Hitching should be secure. Use a top quality draw pin and safety chain.
- Make sure you can signal your intention to turn on the roadway – use escort vehicles if necessary.
- SMV sign should be clearly visible on the rear of the wagon.
- Never carry a large bale on the front end loader while pulling a loaded wagon.



Front end loaders must be equipped with proper restraining devices for handling large bales. Counterweights on the tractor may help prevent tipping.

Summary

The basics of equipment safety apply to large bale harvest and handling. The major new risk encountered when switching to this system of hay handling is the new forage package itself. These bales can roll, and their tremendous weight is sufficient to crush a human body.

Please keep the following points in mind when working with large bales:

- Good maintenance and timely lubrication minimize the breakdowns that can lead to frustration and carelessness.
- Never attempt to unplug a baler or carry out adjustments and repairs with power engaged.
- Place bales in a manner that will minimize potential for rolling.
- Handling equipment should be large enough and properly counterweighted.
- When handling or transporting bales, use properly-designed equipment that incorporates restraining devices. Avoid sudden motions, and travel at low speed.
- Always carry bales as low as possible with a tractor loader.
- Bystanders and other workers should stay well clear of all big bale operations. And remember, NO RIDERS!
- The best instructions for safe, efficient use of equipment can be found in the manual. Every operator should be familiar with this information.

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