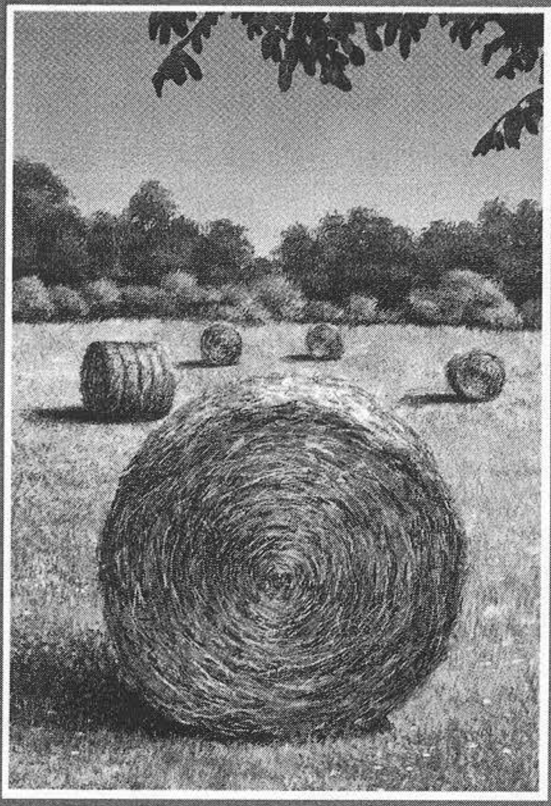
THE BALEWRAPPING HANDBOOK



Trioplast AB

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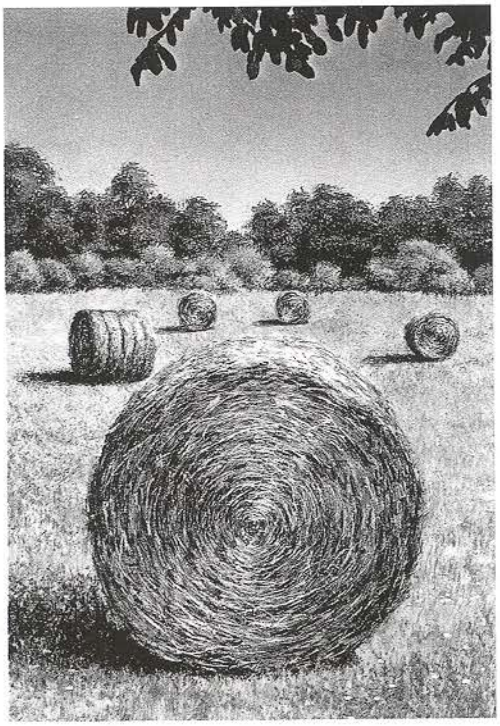

A guide to
the efficient production
of balewrapped silage.

TRIOPLAST

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Foreword

Today, it is essential to provide winter feed at economic levels. Now, more than ever it is important to reduce spoilage and wastage to a minimum.

Producing silage is no longer considered just another seasonal activity but is now regarded as a highly developed science that requires care, attention and the use of the correct equipment and techniques.

This handbook will be of great assistance. It is published by one of Europe's leading balewrap stretchfilm producers and is a guide to the efficient production, storage and handling of baled silage.

It includes details of all the major technical aspects of the subject as well as many of the important points which are less well known. It is a valuable source of reference and has been compiled with the help of many experts from the major silage producing countries of the world.

It will be especially useful to all those involved with the production and use of silage as well as to the agricultural student who wishes to acquire a greater knowledge of the subject.

In introducing The Balewrapping Handbook I am pleased to note that it is to be widely distributed. It is available in several languages and will be kept continually updated.

I am confident that it will become a standard work on the subject and will be essential reading for all those involved in silage production.

Per Lingvall

Per Lingvall
The Swedish University of Agricultural Sciences
February 1995

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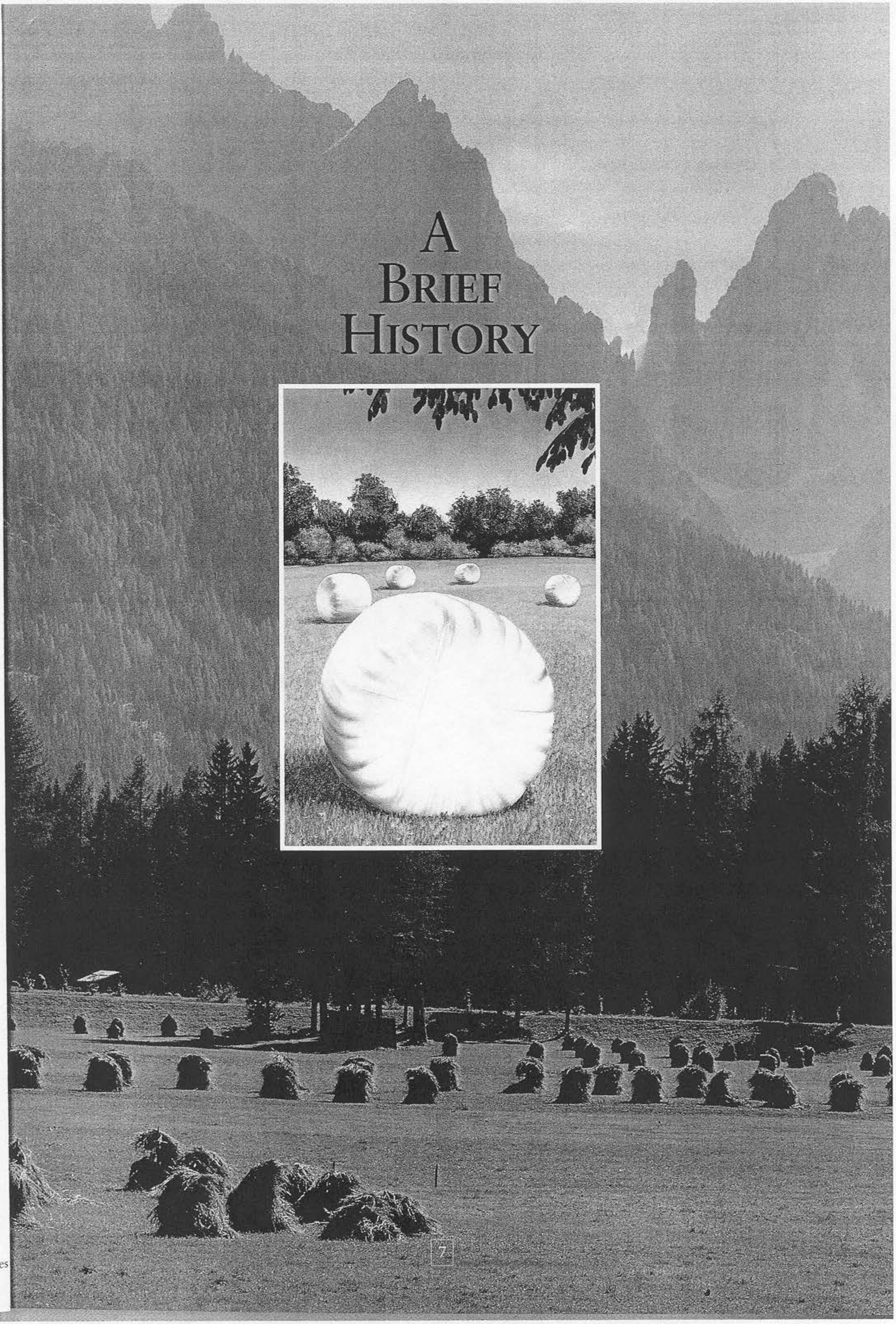
A Brief History



Baled silage is a comparatively recent development when compared with the long history of silage itself.

The origins of silage production are virtually lost in the mists of time. It is thought, however, that possibly as long ago as 7000 BC, corn was preserved in some kind of basic airtight 'silo', a word derived from the Greek word 'siros'. This originally meant an underground, airtight feed store.

There is firm evidence of the use of silage in Egypt between 1000-1500 BC, and silos were apparently unearthed during excavations in the ruins of Carthage.

Silage can be defined as fodder preserved and stored in airtight conditions.

More general interest in the system began in the early 1800's, and even at that time as now, the aim was for rapid filling of the silo, followed by compaction and sealing of the surface to exclude air. The latter was achieved by placing layers of boards on top, which were then covered with up to 50cm of soil. This would generally have produced a low temperature fermentation at under 30°C.

A New Approach

In the mid to late 1800's, a contrasting approach appeared, which was to reduce the rate of filling and compaction, and to delay final sealing until the temperature had exceeded 50°C. This very high temperature resulted from plant cell respiration due to the ingress of air before sealing. The technique became quite widely used, and resulted in a much sweeter silage than the more acidic forage produced from low temperature fermentation. However, the excessive temperatures reached meant considerable losses of nutrients.

It was these losses from the 'sweet' silage method which almost certainly delayed further development, but when work reverted back to the low temperature method, considerable progress and improvements were made. This is reflected by figures which show that in the UK in 1883, less than 12 silos were in use, yet within ten years, there were over 1500!

Much of this early development work in silage production was carried out in France, and it was a French farmer who wrote the first recorded book on the subject, which was published in 1877, and which concentrated on the ensiling of green maize.

Trials continued in France until the early 1900's and between 1920 and 1930 Professor A.I. Virtanen of Finland developed his AIV acid-based additive. AIV was a combination of sulphuric and hydrochloric acid, diluted in water, which was very corrosive and dangerous to handle. It was replaced during the 1960's with the much safer formic acid.

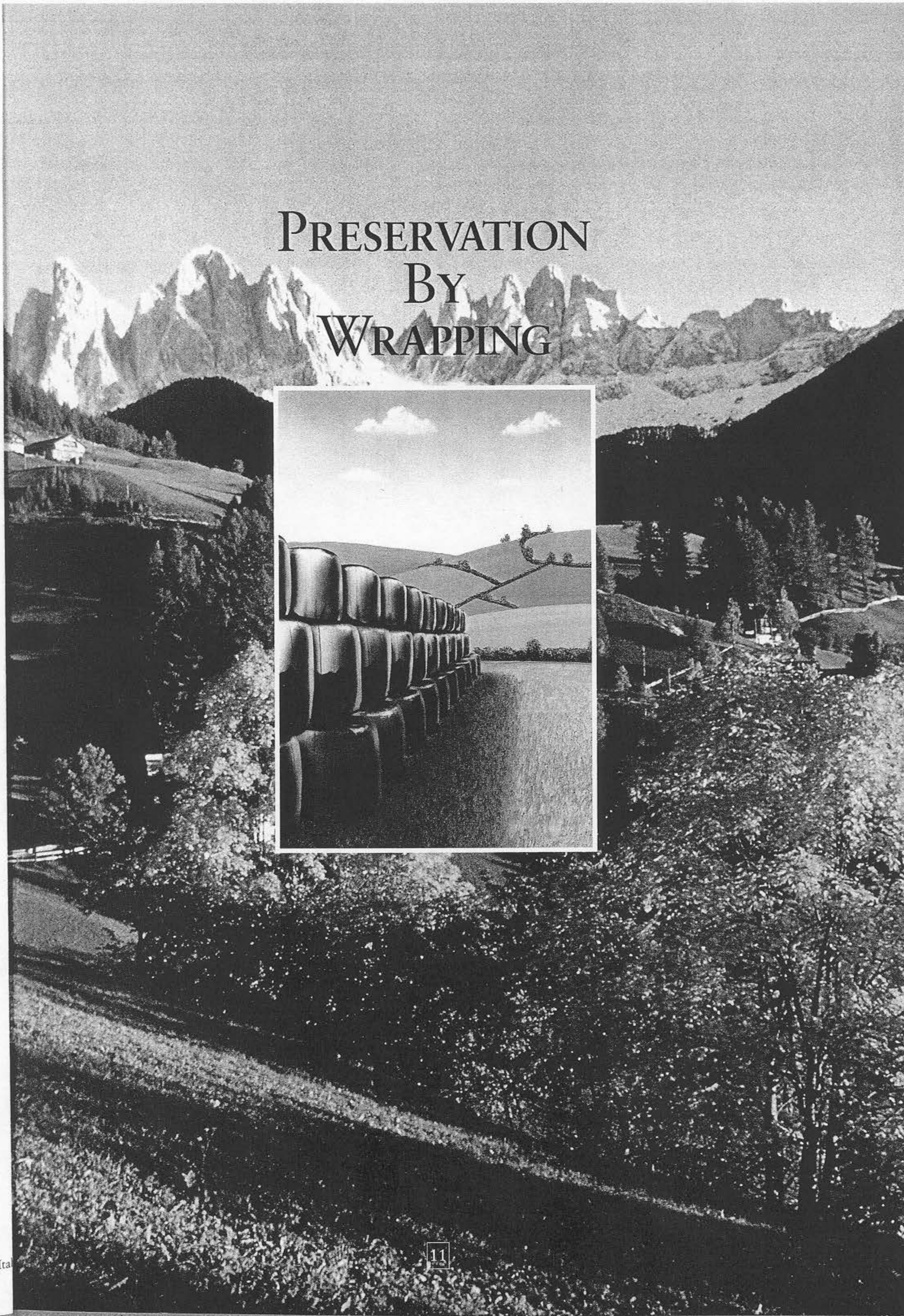
Introduction Of Polyethylene

During the 1970's, the first polyethylene silage bags were used in the UK, a system which was widely adopted for a number of years, though results were rather variable. This was due mainly to the excessive amount of air left inside, and the difficulty with sealing the neck of the bag efficiently.

It was around 1984/5 that the great benefits of wrapping silage bales in balewrap stretchfilm were recognised, and the system was first launched on a large scale in the UK, where it soon gained in popularity, and quickly replaced the old and laborious system of bagging. Balewrapping machinery steadily improved during the years to follow, and led to the appearance of the latest generation of fully automated wrappers. Balers, too, which were intended originally for straw, have improved to produce grass bales better suited to wrapping.

The system has proved enormously popular and successful, and as more and more farmers realise its advantages, and techniques improve, it now accounts for a substantial share of the total silage market in a number of countries. Other countries into which balewrapping has been more recently introduced are now, in turn, experiencing a tremendous growth in the popularity of this unique and innovative system.

Preservation By Wrapping



Each wrapped silage bale is, in effect, an individual silo, which means that crops can be harvested and preserved individually, according to their maturity.

Why Preserve By Wrapping?

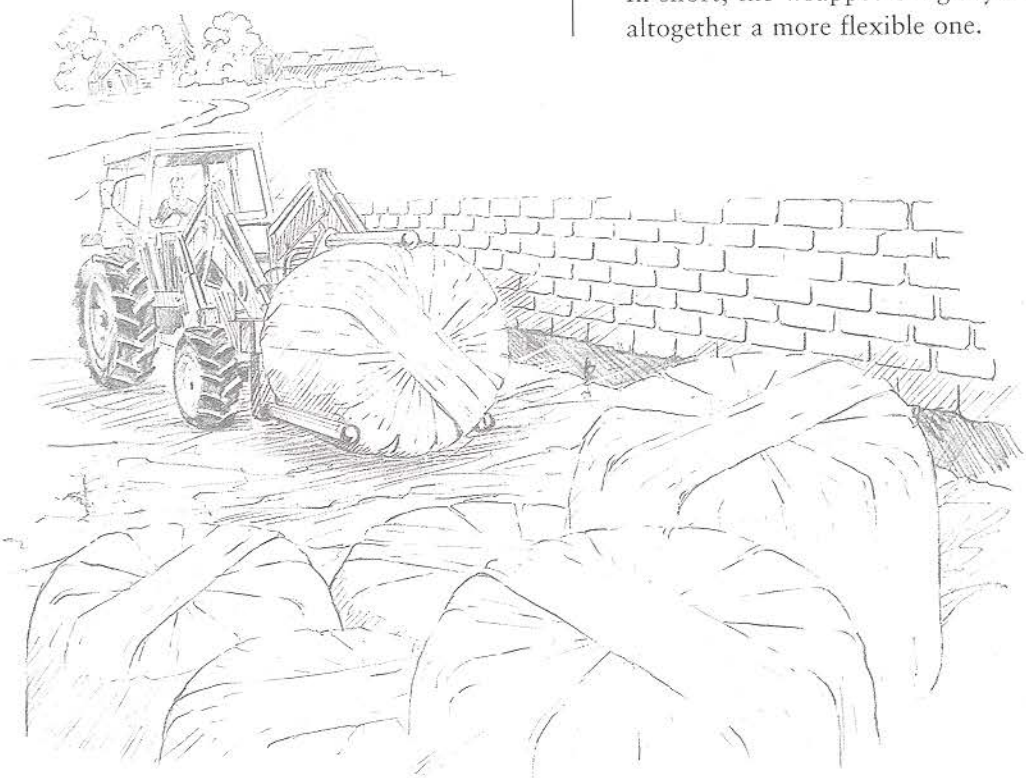
As opposed to bulk silage, where several crops of different nutritional values are likely to be stored together, wrapped bales can be used according to their individual nutritional value. Material of high nutritional value can therefore, for example, be fed to high yielding autumn calvers, whereas lower value crops would be better suited to dry cows, etc.
By careful planning therefore, crops can be utilised in the most efficient way.

Other Advantages Of Wrapped Silage.

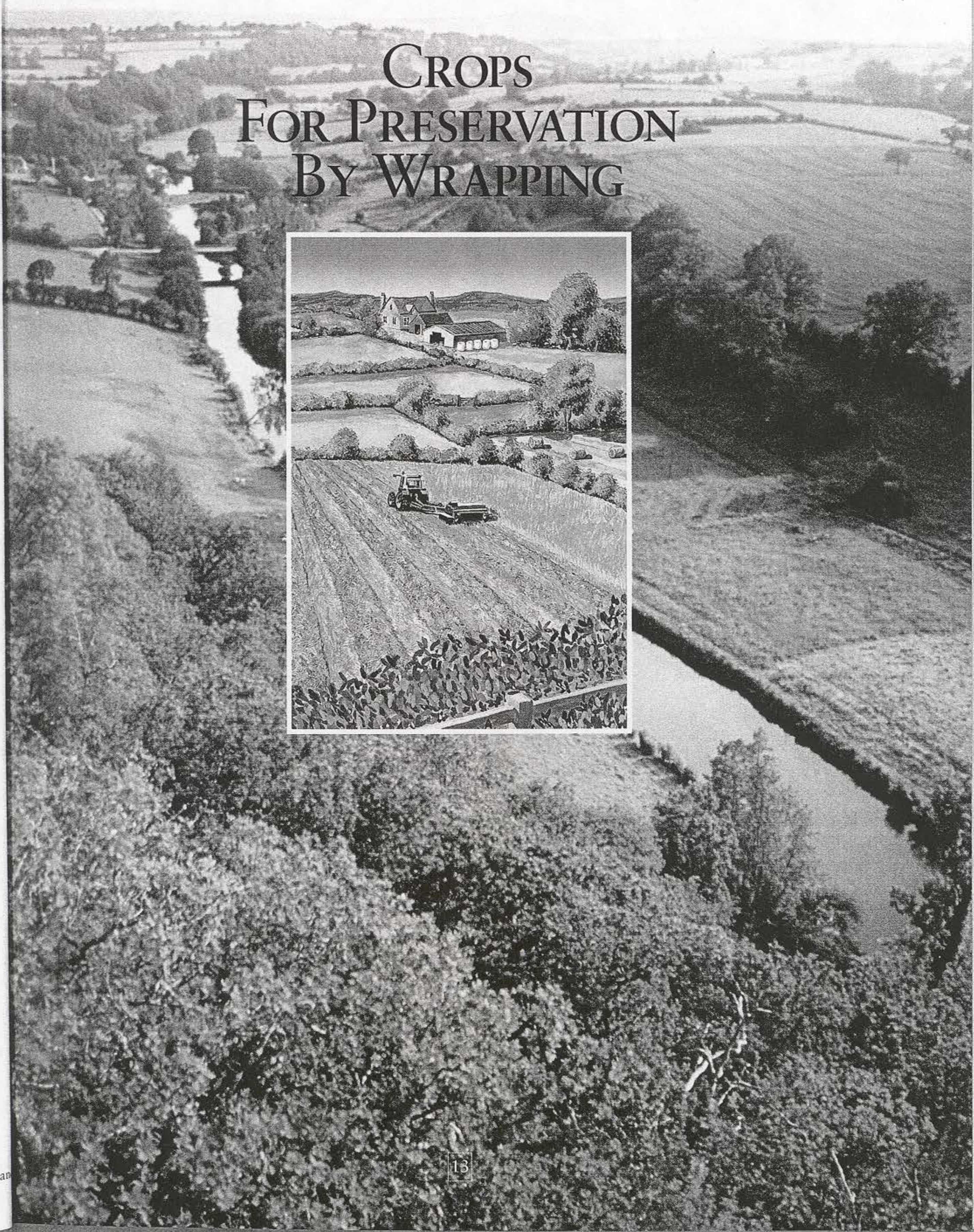
It is easily stored, if necessary in several convenient locations around the farm to suit feeding requirements. Because each bale is a sealed unit of generally higher dry matter content than bulk silage, the likelihood of effluent is extremely small. Also compared with hay-making, successful results are not dependant on long periods of fine weather.

The system requires relatively minor fixed investments, and costs can be limited by using contractors or sharing machinery. Wrapped silage is transportable and is therefore saleable in cases of surplus. It can prove invaluable where summer grass is in short supply. On farms where bulk storage facilities are in use and are full, balewrapping is an ideal way to preserve surplus silage. In these circumstances, it can also prove invaluable in a situation when only a few animals are being fed, when it would be unwise to open the clamp or pit.

In short, the wrapped silage system is altogether a more flexible one.



Crops For Preservation By Wrapping



The objective of the preservation and storage of grass is to retain the high nutritional value and hygienic quality of the forage.

Nutritional Value And Timing

The nutritional value of the crop can be defined as the energy and protein content per kilogramme of DM. It will, of course, affect both feed intake and liveweight gain of livestock. The nutritional value is, in turn, affected by the crop, the time of harvesting, choice of fertilizers and also the degree of accuracy of harvesting and preservation processes.

Swards which are rich in grass require careful choice of fertilizer in order to obtain optimum yield, and those containing clover will have a lower nitrogen requirement. When crops are cut early and there is a balance between energy and protein, they will have a high nutritional value. Timing of harvest is critical in this respect. Normal sugar rich grass crops, intended from the outset for silage, will generally give good results. On the contrary, the practice of saving late cut hay from rain by wrapping it can result in extensive spoilage from moulds.

Crop Hygiene

Good crop hygiene is of vital importance to successful silage production - in other words, clean crops are likely to produce hygienic forage. Contamination from, for example, soil or heaps of old straw with its accompanying butyric acid bacteria can have a disastrous effect, even in a completely oxygen free bale. If fungi are exposed to air inside the bale, moulds and spoilage organisms will grow, and losses can be extensive. The resulting forage does not make good feed, and could seriously affect animal health or the quality of food stuffs produced.

Heaps of old straw or grass and any wildlife carcasses must be removed before harvest. These can cause considerable losses if picked up in the bale, and the latter represent a particular danger in that if they are enclosed in the bale, the very toxic poison, botulin, can be produced, by an anaerobic organism i.e. an organism which thrives in the absence of air. The risk of this is especially high in bales of low dry matter content. The feeding of silage in which this botulin is present can have fatal consequences.

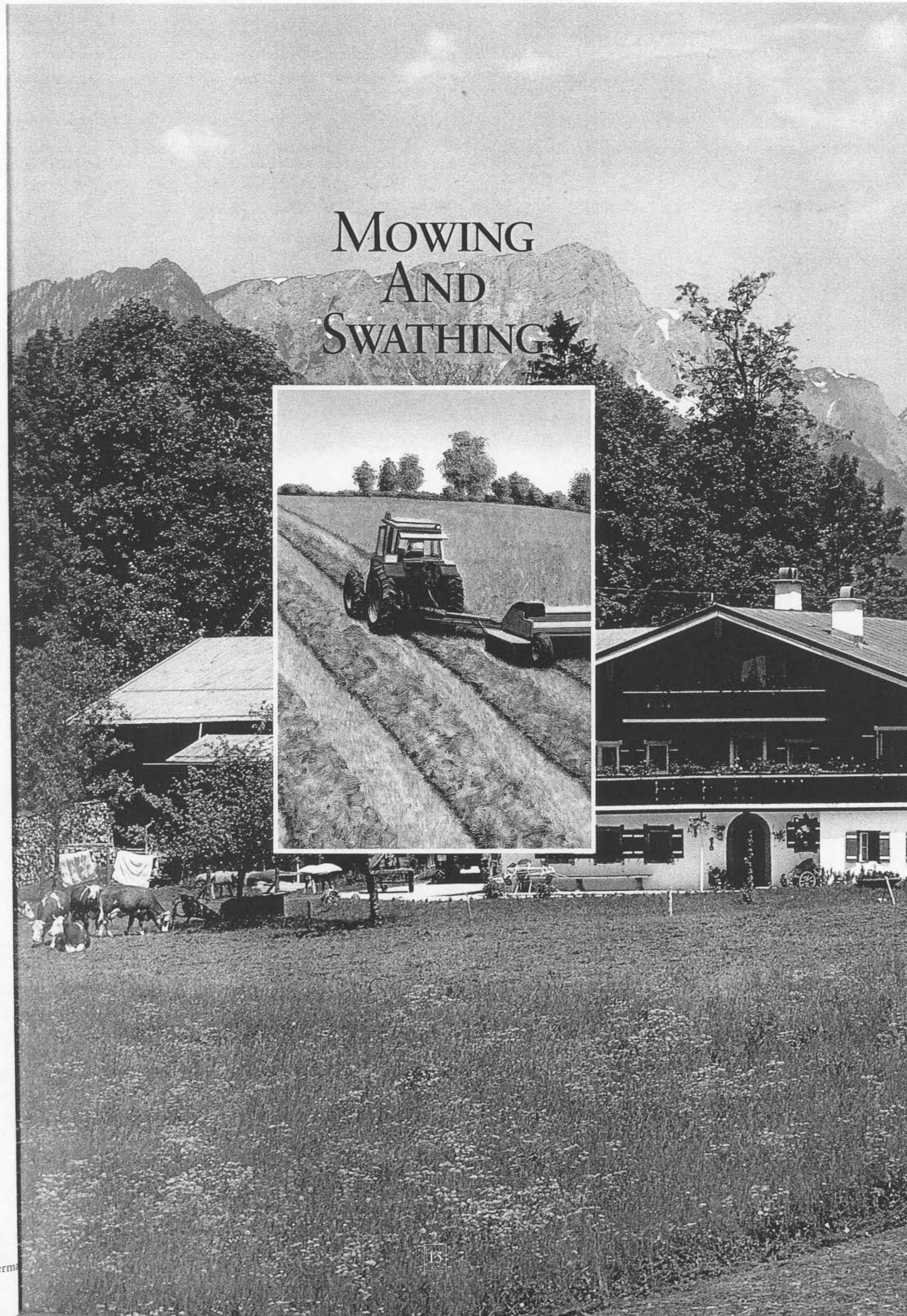
Incorrect timing of manure applications can also create hygiene problems and this is therefore best carried out before the crop starts actively growing.

The growth of negative bacteria can be prevented, amongst other things, by the correct degree of wilting and the prudent use of suitable additives. Fungal growth can be minimised by ensuring that all bales are as dense and well-shaped as possible, so that air spaces within are small. Whole crop and maize silage have in some cases been successfully baled and wrapped, but it is generally more difficult to compress these coarse crops sufficiently with existing balers. This means that the bales will be of low density, containing much air, resulting in the growth of yeasts and moulds.

Wrapped silage is particularly susceptible to spoilage from exposure to air, and a well adjusted and skilfully operated baler can normally achieve a considerable degree of compression.

However, it is important to remember that the baler is just one of the contributory factors to a sufficiently dense bale, which include plant biology, harvesting technique, timing, baler speed etc.

MOWING AND SWATHING



Timing is of particular importance during the early stages of silage production.

When To Mow

The time of cutting is important in order to retain nutritional value and also to enable the baler to adequately compress the crop and produce a dense, well shaped bale. As soon as the crops are mown, the natural breakdown of organic matter will commence.

As a rule, mowing should begin when the grass is in ear and the clover is budding i.e., legumes should be one quarter in bloom and grasses in the early boot stage. Unfortunately, weather and resources have a considerable bearing on the time of mowing. Cutting height should relate to ground conditions, and in general a height of 8-10 cm. is recommended in order to avoid contamination. There is in any case no point in cutting too low, as the base of the plant is of poor feed value.

How To Form The Swath

The ideal mower-conditioner produces a fluffy swath of rectangular cross section (see diagram 1). This system helps reduce wilting time by bruising the crop and releasing plant sugars, which makes them more accessible to the lactic acid producing bacteria.

Diagram 1

With round balers, if the baler pick-up width is the same as that of the bale chamber, the swath should be almost half of this width. On balers where the pick-up width is wider than the chamber, the swath should be the same width as the pick-up.

For square balers, manufacturers' advice concerning swath width varies. Experience shows that if swath and pick of width are the same, driving must be very precise. It is therefore better to form a swath which is two-thirds to three-quarters of the pick-up width.

Some more recently introduced systems leave the grass spread relatively thinly over the whole ground area, the intention being to allow rapid and more even wilting before forming into a swath and baling. It is claimed that as much as 5% more moisture can be evaporated within the first 24 hours than with the best of other systems.

Particular care should be taken with this technique regarding the avoidance of soil contamination.

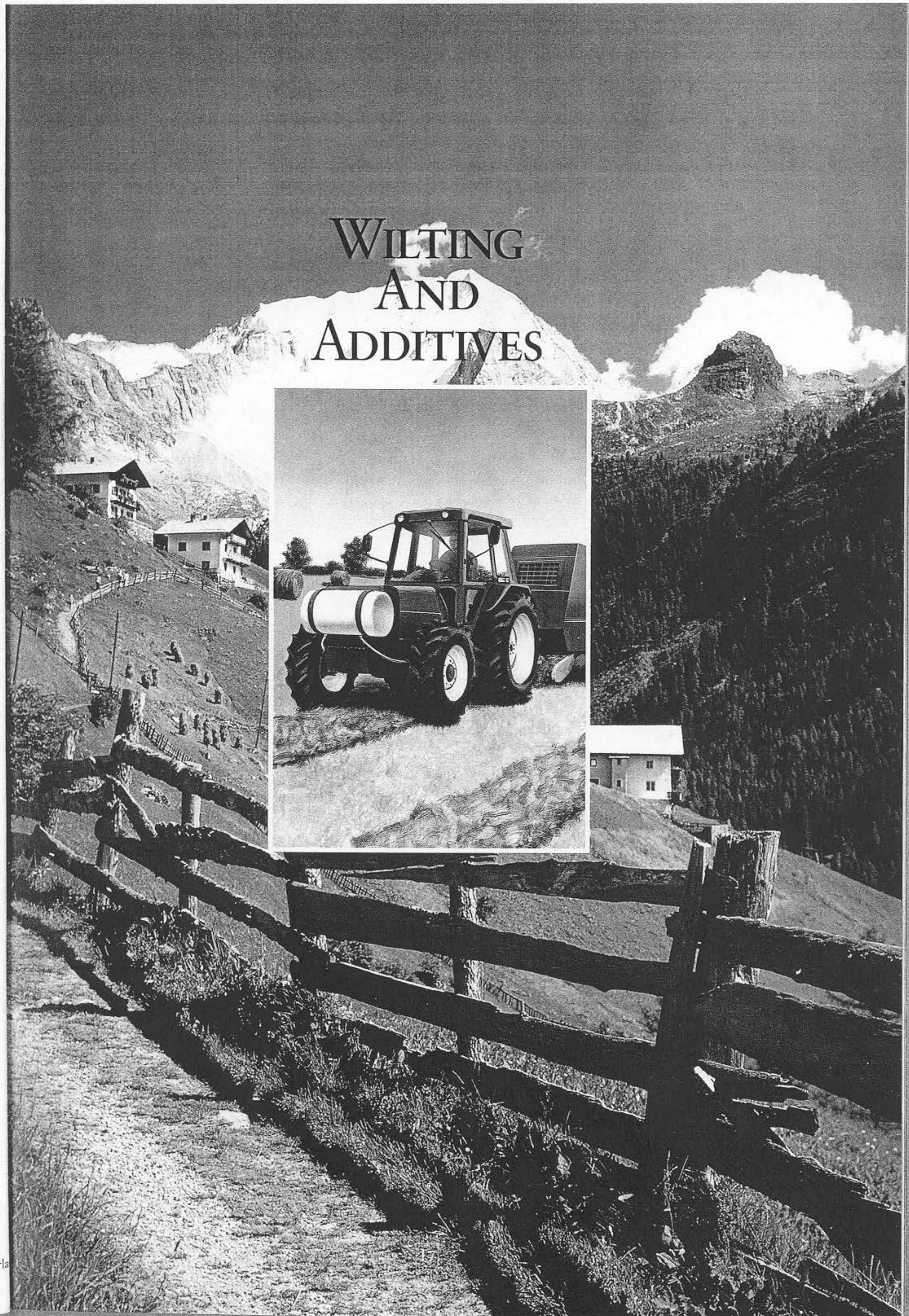
How To Handle The Swath

From a hygiene point of view, it is preferable not to turn the swath, but in variable weather this could be necessary and then care must be taken. Even in unfavourable conditions do not leave the swath more than 2-3 days, but if this is for some reason unavoidable, a suitable additive should be used. In damp, warm conditions moulds in the swath grow rapidly.

Speed Is Of The Essence.

Rapid and efficient harvesting and wilting reduce nutritional losses and improve the final quality of the end product. Losses in this case should not exceed a few percent, whereas bad weather or prolonged wilting could mean that losses reach 10% or more. To facilitate a rapid and successful harvest, co-operation between farmers over machinery sharing can be very worthwhile.

Wilting and Additives



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Wilting is a most important phase of successful baled silage making and one which can have a major effect on the end result.

The Importance Of Wilting

By dehydrating the plant, the growth of negative bacteria is diminished or halted. Even at 35% DM, the clostridia bacteria survive only with difficulty.

Wilting is important both for a good fermentation and adequate bale density, but 45% DM should be exceeded to obtain the best results (see table 1). For wrapped silage, there should be no necessity for additives beyond 40% DM. If moulds do occur under these conditions, they are likely to be the result of poor baling or wrapping, or damage to the film after application.

In favourable conditions the aim should be for a wilting period of no more than 24-36 hours.

TABLE 1. The influence of dry matter content on silage quality.

	Dry matter %			
	<25	25-35	35-45	>45
pH	4,5	4,8	4,9	5,4
% of total Ammonia NH^3N	11,4	9,1	6,8	4,3
Lactic acid, % of DM	5,6	4,6	3,5	1,7
Butyric acid, % of DM	0,32	0,03	0,01	–
Clostridia Spores number per gramme of silage, approx.	>1000	500	80	5

Comments : The pH level is relatively high due to the limited proportion of lactic acid. Ammonia should not exceed 8% to be acceptable. The proportion of butyric acid should not exceed 0,1% and the number of Clostridia Spores should not exceed 1000 per gramme. As shown, where DM exceeded 45%, the quality was very good. Source: Bagged round bale silage. Trial in field approx. 4000 bales.

Lingvall, P. and Markström B. 1986.

Wilting And Bale Density

Wilting also affects bale density, which is directly related to the degree of compression. No baler can dehydrate the plant cells entirely during the short period of time involved in compression of the crop. But if the cells have already been dehydrated, the baler then has a good chance, in the right hands, of producing dense well-shaped bales.

Through heavy compression of soft crops, the volume of plant pores is diminished, which is of great importance in storage when temperatures and pressure vary.

It is important to note that simply because some bales of low dry matter may be heavy, they are not necessarily sufficiently dense. Remember that bale density is a measure of the number of kilograms of dry matter per cubic metre.

TABLE 2. Example of the influence of the proportion of dry matter on the degree of compression, on the consumption of plastic material and on the quantity of bales per tonne of silage dry matter.

	Proportion of DM, %			
	20	35	50	58*
Density, kg DM per m^3	89	148	201	264
Amount of plastic material, kg per tonne DM	8,4	5,0	3,7	
Number of bales per tonne DM	7,6	4,6	3,4	

*Comments: *From a modified square baler. The results show how important the DM % is in respect of costs and operation.*

Lingvall, P.

Dry matter content is of great practical and economic importance. Table 2 shows how the bale density, the quantity of grass per bale and the film consumption all vary according to the DM content. Correct DM content is essential to minimise labour, machinery and film costs. Well wilted bales keep their shape after good compression, and can be stacked without problems.

Adequate wilting can help double the eventual density of the bale, and consequently reduce costs and improve the final quality of wrapped silage.

The Importance Of Weather Conditions

Where weather conditions are not good, and the crop is deteriorating rapidly, an attempt must be made to salvage as much as possible. Wet crops are very much at risk from bacterial growth, and a remedy must be found. This is where additives come into their own.

Chemical Additives

Organic and inorganic acids.

The organic additive formic acid and combinations of it and other active ingredients are widely used. Formic acid acts by decreasing the pH level of the crop, and hindering the growth of negative micro-organisms and biochemical deterioration.

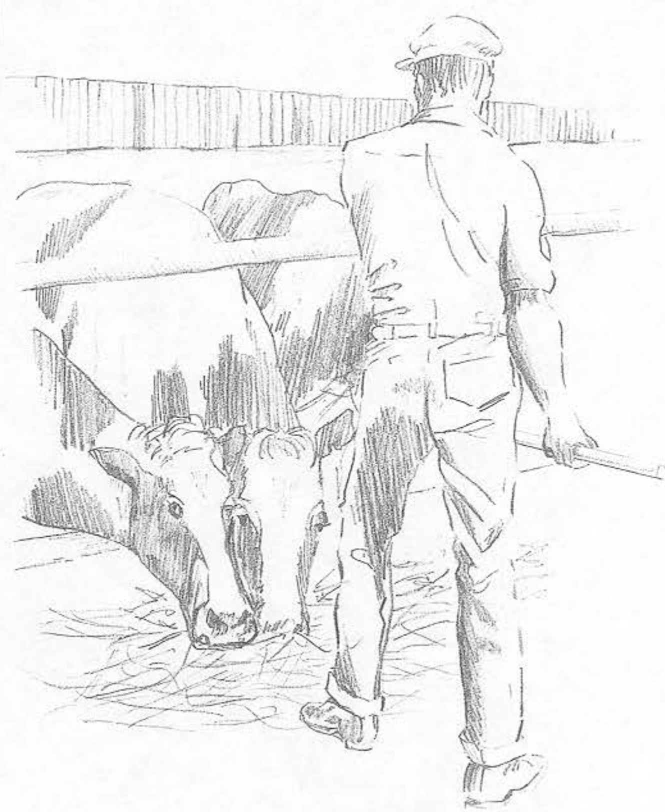
Salts of inorganic as well as organic acids are available for application both in powder and liquid form. Additives containing sodium nitrite and hexamethylene tetramine will help prevent microbial growth and especially that of clostridia. In a low pH environment, sodium nitrite has the advantage that it will turn into a gas and disperse more readily throughout the bale, irrespective of how the material was cut.

Additives Which Add Nutrients To The Crop

Molasses, a natural product containing about 50% sugar, is added to stimulate lactic acid production by boosting the existing level of fermentable crop sugars. It is safe to handle, and being of high density, it also has a positive effect on bale density by filling the air spaces within the bale, and thus increasing storage stability by reducing the likelihood of air circulation. To ensure that no molasses can leak from the bale with any effluent, the crop should be wilted to a DM content (minimum around 30%) at which there will be no effluent.

Dried Sugar Beet Pulp And Molasses

The incorporation of a 50/50 mixture of dried sugar beet pulp and molasses into the crop produces three benefits. It provides added nutrients for the lactic acid bacteria, it is a moisture absorbent and also increases bale density.



Biological Additives

The use of freeze-dried lactic acid - producing bacteria has become more common in recent years. The idea is based upon the addition of a high concentration of homofermentative lactic acid producing bacteria in a water solution when baling. It is preferable to make the solution 12 hours before use to preferment it and thus ensure that it is active. This type of additive is known as an inoculant.

In crops which are of very low dry matter or are low in sugars, the benefits of this technique are limited, and in fact the result may be even worse than with no inoculant if sugar levels are very low.

Enzymes can also prove of benefit, provided that they are added in sufficient quantity. These are intended to break down the carbohydrates of the plant cell wall into simpler sugars which can be easily utilised by the lactic acid producing bacteria to ensure good preservation.

Inoculants and enzymes are also available together in solution form, the combination providing the lactic acid bacteria with sufficient nutrients for a good preservation.

Advice For The Use Of Additives

Diluted organic acids work best at DM levels of up to 30%.

Sodium nitrite-based additives are effective on clostridia and fungal growth.

All additives will reduce the breakdown of sugar and in these circumstances any resulting problems such as fungal growth resulting from damage to film may be particularly serious.

TABLE 3. Sodium Nitrite & Hexamethylene Tetramine UT

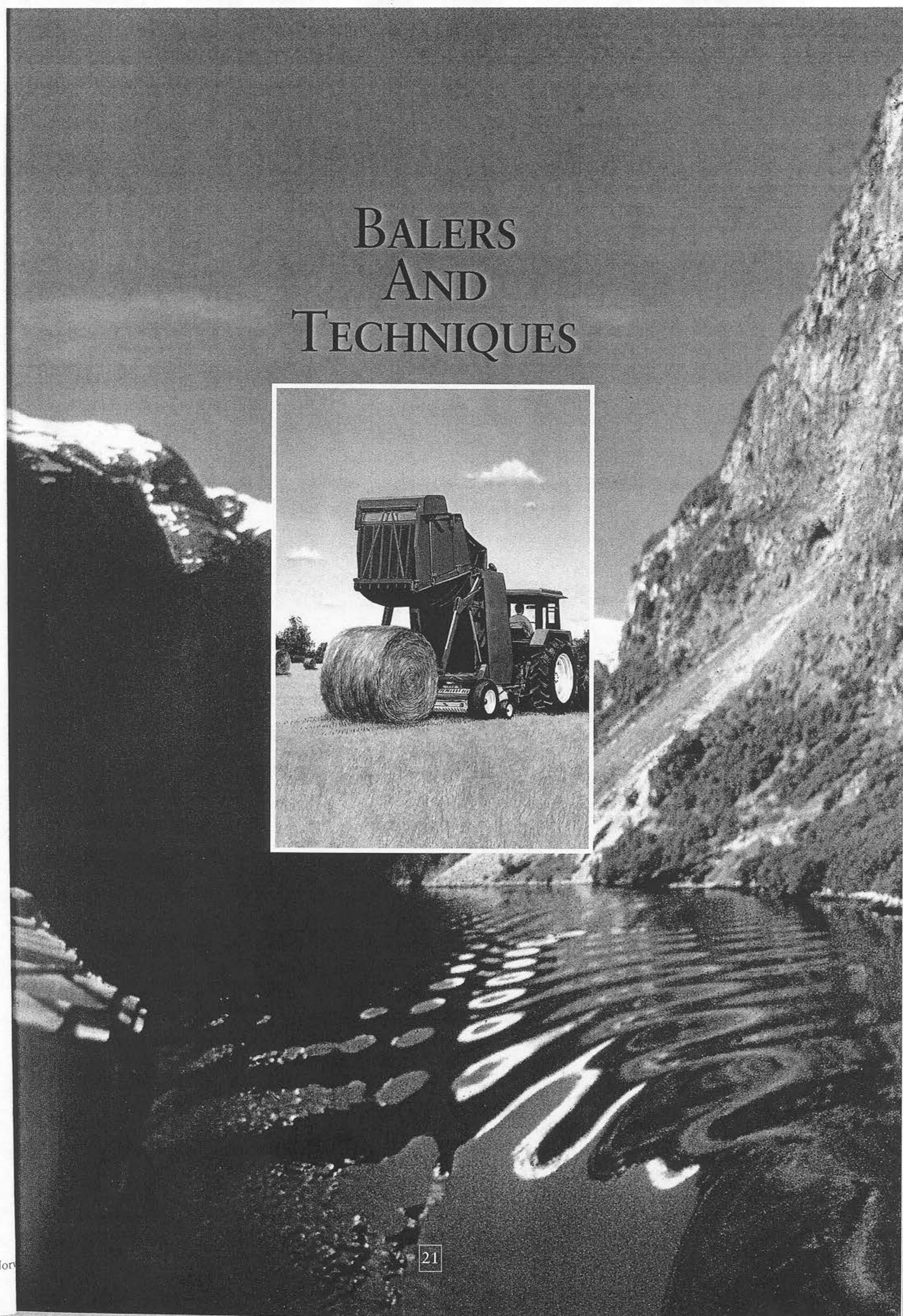
Trials in field, 5 farms x 30 bales

Bale:	4 farms, 120µm bags	
	1 farm, Kverneland wrapper 6 x 25µm Stretchfilm	
Balers:	Round/Fixed chamber	
	Without additive	**With additive**
DM proportion, %	41,6	43,2
Surface mould	<1	<1
pH	5,1	4,9
NH_3 -Ng/kg tot-N	81	67
Butyric acid, g/kg DM	7	1
Number of Clostridia spores per gramme of silage	126,000	2500

** Expressed as a % of bale surface area.*

The field trial in Table 3. shows that the number of clostridia spores can be reduced some 50 times.

BALERS AND TECHNIQUES



To make good silage, two essential factors are that the bales should be well shaped and of high density.

What Affects Bale Density?

* Dry matter content (DM) of the material
* Composition and degree of maturity of the crop
* Type of baler (round balers with fixed or variable chamber or square balers)
* Speed and driving technique
* The cut length of the material
* Adjustment of the baler
* Available engine power
* Choice of twine or netwrap (round bales)

The Influence Of Dry Matter Content On Bale Density

The dry matter content is the most important factor affecting bale density. Chart A shows the relationship between the DM percentage and the density of a number of bales made with round balers during trials carried out on first and second crops.

Furthermore, driving technique, ground speed, type and adjustment of baler and also timing of harvest are influencing factors.

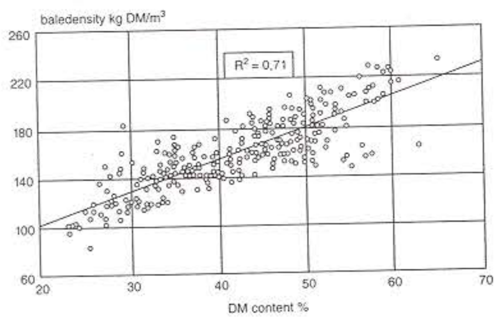


Chart A. It is clear from this that final bale density mainly depends on the crop DM content. At a DM level of 50%, the bale density is between 150 and 200kg DM/cubic metre. This is directly influenced by operator driving technique.

Different Types Of Balers

Round Balers

These work on two different principles i.e. variable and fixed chambers. In recent years, a combination of these two basic types, so called hybrids, have appeared on the market. The main differences between the various types are shown in diagrams 2a, b and c.

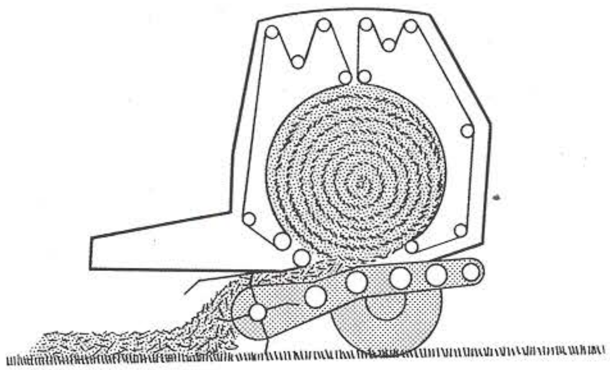


Diagram 2a

The chamber volume varies. The belt systems that cause the bale to rotate follow and compress the green mass as soon as it enters. The power requirement remains constant during the whole compression phase.

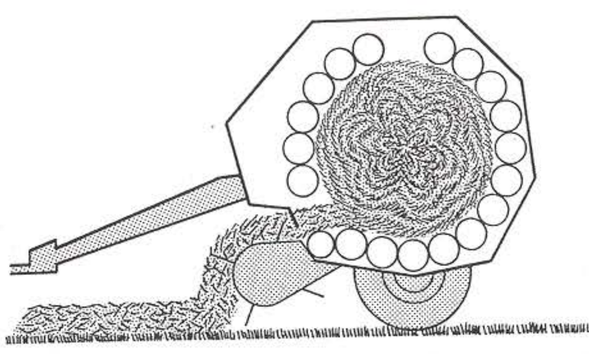


Diagram 2b

The volume of the fixed chamber baler is constant and the bale is rotated by means of shafts, belts or chains around the perifery.

The green mass is not compressed until the bale chamber is full, which can result in a softer core. The outer part of the bale is however usually harder than that from a variable chamber baler. The power requirement increases as the cycle progresses.

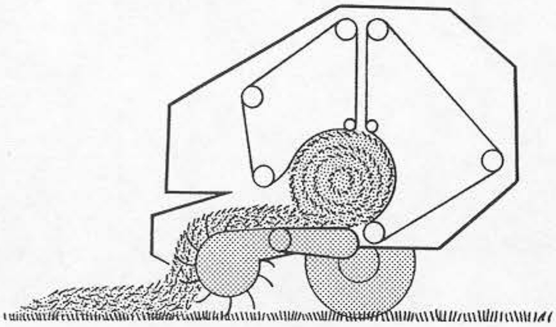


Diagram 2c

During the first part of the compression phase, the hybrid baler is working as a fixed chamber machine, although the volume is considerably smaller. The bale is not compressed until the constant part has been filled,and it then works on the variable chamber principle and results in a looser bale core and having a somewhat smaller diameter than the bale from the fixed chamber baler.

Square Balers

Most square balers work on a similar principle (see diagram 3). Bale width and height vary from one make to another, producing either square or rectangular cross sections. In general, there are two main bale widths, either 80cm, or 120cm.

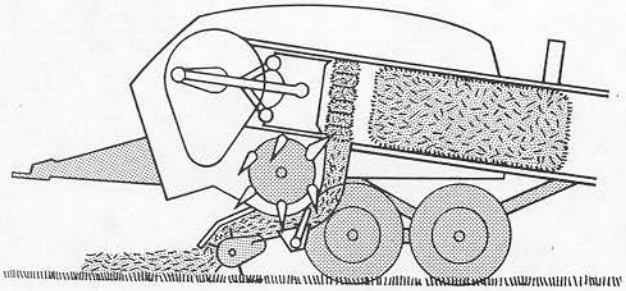


Diagram 3

How To Choose The Appropriate Type Of Round Baler And Size Of Bale

A number of factors will influence the choice of the appropriate type of round baler i.e., for maximum bale density. The fixed chamber balers are the most common today. The difference between the baler types can be explained by studying the core and outer layers of, for example, a 1.2m x 1.2m bale.

If the bale core is taken to be 80 cm in diameter, the volume of this core is approximately the same as that of the whole of the remaining outer part of the bale. Chart B shows the results of a German trial performed by Deutsche Landwirtschafts-Gesellschaft, DLG. It shows that the core produced by the fixed chamber baler is of lower density, whereas the density of the outer part of the bale is higher than that from a variable chamber machine. Therefore, optimal use of the two types of modern balers should produce bales which are of very similar overall average density.

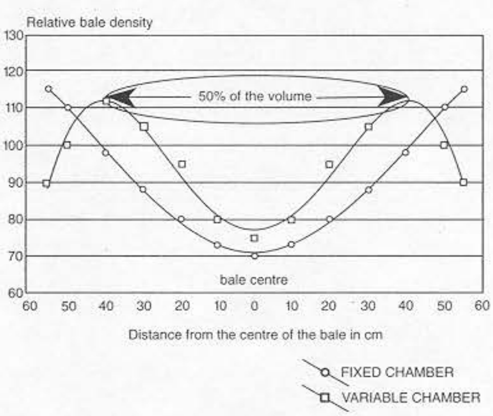


Chart B. The chart refers to some work carried out by Deutsche Landwirtschafts-Gesellschaft, DLG and shows in relative figures how the density of a bale produced by fixed and variable chamber balers can vary from the centre of the bale outwards.

From experience, it has been found that a 1.2m x 1.2m round bale is the size best matched to round balewrappers and other related equipment. The weight of bales of this size varies between approximately 400-700kg depending on DM content, etc.

Driving Techniques

With Round Balers

By driving carefully and correctly, well shaped bales of high density can be produced, which are easy to wrap. To achieve this, it is essential that the swath is of rectangular cross-section.

If the swath is much narrower than the pick-up width, driving technique should follow that shown in Diagram 4. Avoid zig-zagging, which may result in misshapen bales and difficulties with handling them.

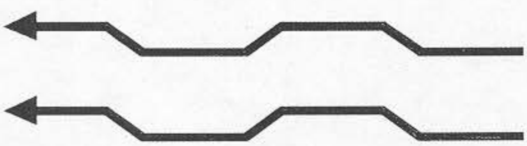


Diagram 4

The Importance Of Correct Speed

In order to produce dense uniform bales, it is important to keep a close watch on the feeding of material into the baler, which usually means that it is difficult to both drive fast and produce well shaped bales. It is not good policy to rush the process of baling, and it should be remembered that if the maximum number of bales per hour is the priority, the result is likely to be poor. Table 4 indicates the benefits of slower driving.

TABLE 4. Example of influence of the speed on the bale density

Crop:	10.0 MJ and 12.4% of crude protein in DM	
Baler:	MF 828	
Speed (per hr):	8 km	6 km
Dry matter proportion:	35.3	36.4
Weight of bale in kg:	621	673
Density = kg DM/m^3:	167	181
Number of bales:	20	20

Lingvall, M 1991

Fixed Chamber Balers

As the compression of the bale does not start until the bale chamber is full, it is possible to drive reasonably fast until the later stages of bale formation, (in most cases, there is some form of display on the baler to indicate when the chamber is full). It is then best to gear down and drive more slowly whilst completing the remainder of the bale. Another way is to stop and rotate the bale briefly before continuing.

When using a fixed chamber baler, the final phase of compression is very dependant on how much power is available to rotate the bale in the bale chamber. With certain balers, it is possible to continue compression for a time after the display indicates that the bale is complete. However, advice should be sought from the supplying dealer or manufacturer to determine just how much the bales can be compressed without causing mechanical damage.

Variable Chamber Balers

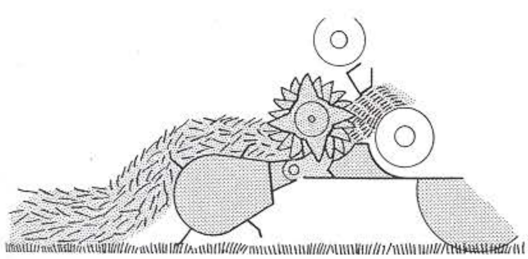
With this type of baler, the speed initially should not be too high, as compression begins from the start. Experience has shown that with the variable chamber baler incorrect driving technique is more likely to produce badly shaped bales than with fixed chamber machines.

Square Balers

To facilitate successful square balewrapping, correct adjustment of the baler is essential, in order to achieve good bale shape and density. Driving technique and bale length should be such as to avoid "banana - shaped" bales. The angle between the bale side and end must be 90 degrees to reduce the risk of film slippage during wrapping.

Pre-Cutting Balers

In recent years, both round and square balers which pre-cut the crop have appeared on the market. Pre-cutters consist of a device which pulls the material across a number of knives, which can if required be retracted if hay or straw are being baled. Normally these are spaced between 45-70mm.



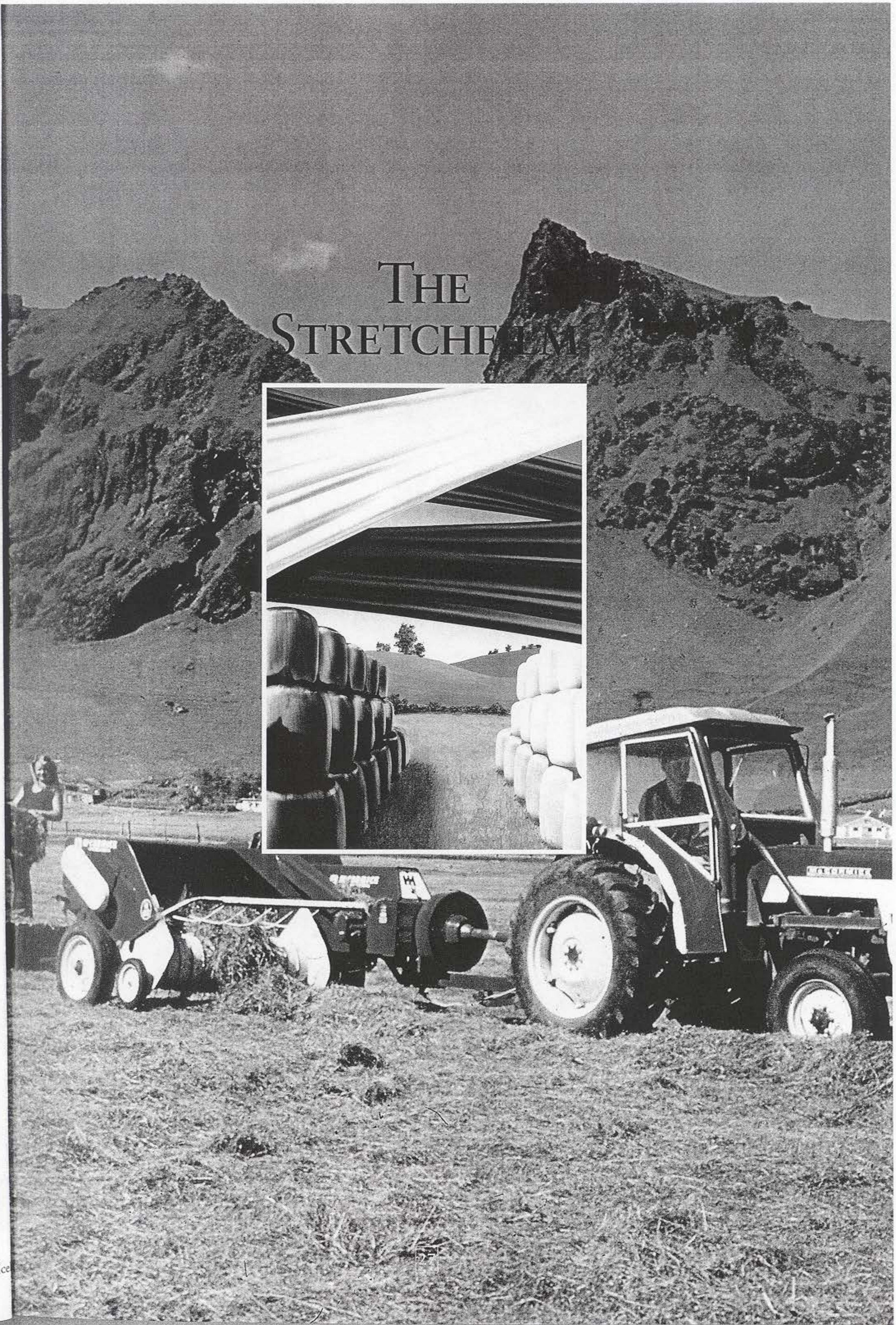
Trials carried out in Sweden and Norway on round bales show that at a DM of around 30%, pre-cutting does not result in any significant change in bale density. According to German trials, however, a fixed chamber baler equipped with a pre-cutting unit can increase density of 50% DM material by about 15% compared with that from a standard fixed chamber, and in the UK density increases as high as 20% have been claimed. If density can in fact be increased to this degree, then calculations have shown that, taking all other cost factors into consideration, wrapped silage can prove to be less expensive to produce than that from a pit or clamp.

Other advantages are that bales made from pre-cut grass come apart more easily for feeding, and where additives are used, their dispersion within the bale is likely to be improved.

Twine Or Netwrap?

Netwrap is the most convenient method of securing round bales although more expensive. Furthermore, twine also ensures that the diameter of the bale is better maintained compared with netwrap, resulting in an improved density by up to 10%. The use of netwrap saves time and avoids the danger of twine being trapped between film layers during wrapping, which can allow air into the bale. For square bales, it is particularly important to choose a high quality twine to enable maximum bale density without breakage.

The Stretchfilm



The stretchfilm performs a vital role in the preservation of wrapped silage bales.

Stretchfilm is a product manufactured from polyethylene, which is made up of carbon and hydrogen, and is derived from oil. It is environmentally friendly during production, use, and energy recovery.

Stretchfilm for balewrapping must be of high quality in order to meet a number of requirements. It should have good mechanical properties, a high level of tack and should be UV-stabilised to protect it from damage by sunlight. It should preferably be white.

White film will achieve maximum possible heat reflection, whereas at the other end of the colour scale, black film will absorb the most heat. Any marked temperature increase within the bale is likely to mean an increase of butyric acid level at the expense of lactic acid. It has been shown in trials using coloured film ie. other than white, that even at a depth of 10 cm below the bale surface, the temperature was 10–30 degrees C higher than where white film was used.

The Swedish National Machinery Testing Institute and the Swedish University of Agriculture and Science have co-operated with European stretchfilm manufacturers in trial work to establish the properties required of a successful balewrap film.

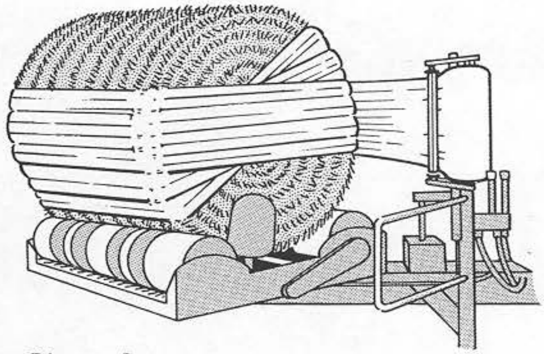


Diagram 5

The trials have given a good indication of the relationship between film properties and silage quality, and have resulted in recommendations regarding film width, pre-stretching, overlapping and number of layers. The work which was carried out on round bales used 500mm width film of 25 microns thickness, applied to the bale after 70% pre-stretch and overlapped 50% (see diagram 5). It is clear from the results that the choice of film can have a considerable effect on the degree of spoilage where it occurs and also nutritional values.

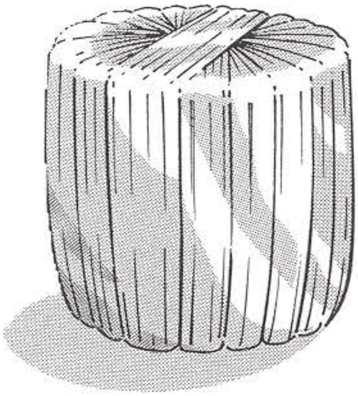
TABLE 5. The influence of the method of packaging on storage damage and losses (round bales). Comparison between bags and two stretchfilm qualities.

Method of Treatment	No. of bags per bale	Condensation kg per bale	Number of fermenting fungi per gram silage	Surface fungus attacks % of the surface of the bale	Loss %
Bags					
0.10mm	1	8	158,500	6	17
0.10mm	2	3	125,900	5	11
0.12mm	1	6	126,000	5	11
0.12mm	2	1	19,900	6	13
Stretchfilm 0.025m x 4 layers	kg per bale				
High quality	0.78	0	2,500	2	12
Low quality	0.76	0	25,100	8	17
Stretchfilm 0.025m x 6 layers					
High quality	1.09	0	1,000	0	7
Low quality	1.08	0	3,900	7	16

Table 5 shows a comparison between bagging and wrapping on the one hand, and on the other between different qualities of stretchfilm. The film around the bale must be as oxygen-tight as possible, both itself and between the layers. The crops involved were clover/grass which had been wilted to 38% DM and compressed to 177kg. DM per cu. metre. It was clear from this work that any space between film and bale is likely to produce condensation and surface moulds, which is a particular problem with bagged round bales and misshapen square bales.

By applying stretchfilm tightly and using 6 layers, the circulation of oxygen is considerably reduced, and the resulting lower nutritional losses are reflected in savings which can be considerable when compared with the cost of the film, etc. The trials indicate that inferior quality film could in some cases produce losses as high as those which can result from the use of bags.

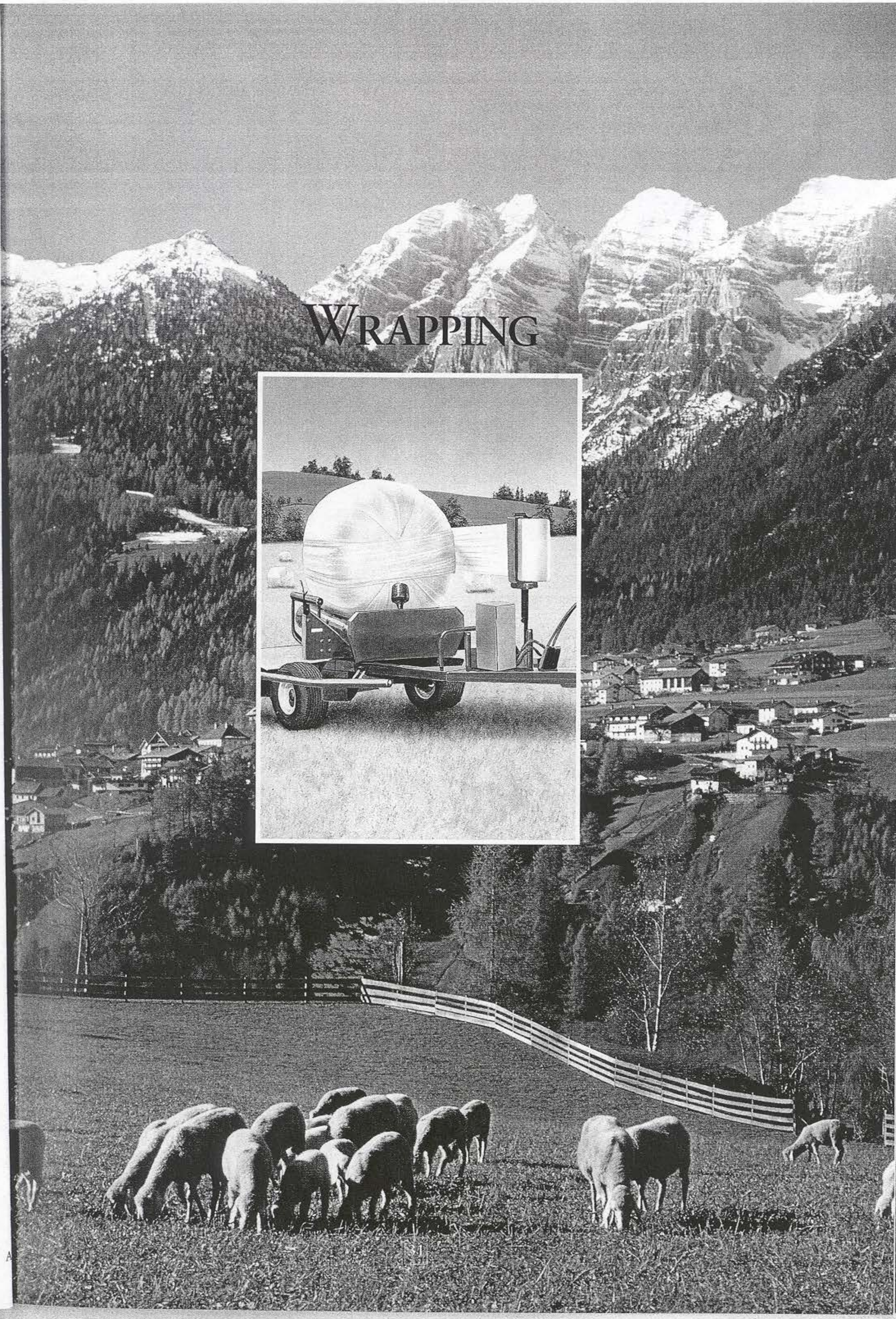
The oxygen permeability of film will increase with increased temperature, eg. a 20 degree rise in the surface temperature of the film could increase permeability by as much as 300%! This could be particularly important with poor quality films where the permeability is already high, even at normal temperatures.



Therefore, a high quality proven film is of the utmost importance during the silage process, and it is essential to choose a high performance product which has been specifically developed for the purpose.

The film reel must be protected against mechanical damage. If the ends, in particular, are damaged, the wrapping operation could well be interrupted. Stored reels should be kept upright on their ends and in their cartons, in cool, dry conditions. In this way, they can safely be kept over winter.

WRAPPING



The object of wrapping is to create the right conditions for crop preservation by protecting it from oxygen.

Round Balewrappers

There are currently available two main types of round balewrapper.

Rotating Table

The bale is rotated about its longitudinal axis at the same time as it is being turned on the turntable horizontally. The pre-stretch unit is stationary (see diagram 6). The amount of film overlap is fixed, which means that when the rotating table has turned once, the curved surface of the bale has been moved by 20 or 30 cm with either 500mm or 750mm film respectively.

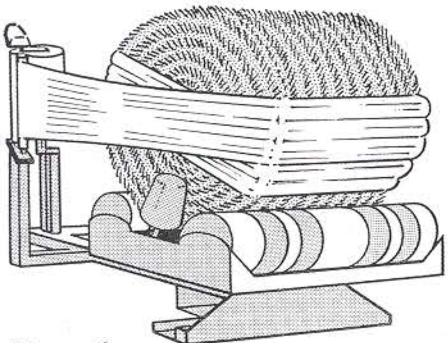


Diagram 6

Rotating Arm

The bale is rotated about its longitudinal axis, and the film is applied by a pre-stretch unit mounted on an arm which rotates around the bale (see diagram 7). The amount of film overlap is determined by the relative speeds of rotation of the arm and the bale, which can be controlled separately.

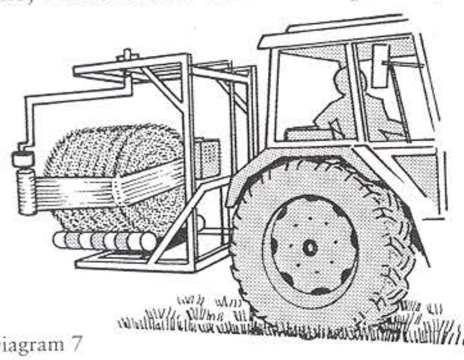


Diagram 7

Square Balewrappers

The move away from modified round balewrappers to purpose-built machines for the wrapping of big square bales has led to several different approaches regarding design.

These generally cope much better with the inherent problem posed by square bales i.e. the difficulty of rotating them smoothly and consistently.

However, in common with round balewrappers, most still use variations of either a rotating turntable and stationary film reel/pre-stretch unit, or sweep arm carrying the same. Some wrappers employ two pre-stretch units/film reels for added speed, and on some sweep arm machines the rollers which support and turn the bale during wrapping are designed also to open up in order to pick it up.

Why Pre-Stretch The Film?

The film is pre-stretched simply in order to make it cling more tightly to the bale, due to its somewhat elastic nature, and also to help the film layers adhere to each other.

At approximately 70% pre-stretch, the optimum effect is achieved, and the 'memory' of the film i.e. its ability to attempt to return to its original length, will be at its maximum. If the film is overstretched, optimum grip on the bale is not achieved, and in addition the film becomes both too narrow and too thin. Equally, understretching will mean that the film is not applied sufficiently tightly to the bale. If for example, six layers of stretchfilm are applied to a 1.2m x 1.2m round bale, this will exert a pressure of approximately 200kg, at each end of the bale.

To check the degree of stretch place two marks horizontally in line, 10 cm apart, on the film reel. Then locate these marks as soon as the film has been applied to the bale, and measure the new distance between them. A distance of 17 cm will indicate 70%

stretch. This method can also be used where square bales are being wrapped.

On a round bale the degree of stretch can be checked approximately by measuring the width of the film on the flat ends of the bale. If the film has been correctly stretched, the width of 500mm film measured in this way should be between 40-42 cm, corresponding to stretching between 80% and 60%. The corresponding width of 750mm film should be 60-63 cm.

It is important that the relative heights of both the film reel and pre-stretch unit are correctly set. For the most efficient film usage, a point half way down the film reel should be in line horizontally with the bale centre. If this is not the case, then extra film will be needed to achieve adequate coverage, and the minimum number of film layers.

Wrap The Bales As Soon As Possible

Grass continues to be alive for some time after mowing.

Cell respiration is very active as long as oxygen is available. This respiration consumes sugar, and produces carbon dioxide, heat and water, which means spoilage.

Nutrients disappear quickly and wrapping should take place within two hours of baling in order to create favourable conditions for preservation. Careful planning of the operation is essential.

Film Application On Round Bales

By using what is known as the 2+2+2 method, each layer of film is overlapped 50% by the next, although in practice, most wrappers provide an overlap of approximately 55%, to give an added margin of security. With 50% overlap, half a turn of the bale about its longitudinal axis is needed in order to apply two layers of film to all parts of the bale. This means that after $1^1/_2$ turns, six layers of film (2+2+2) should have been applied.

By using 750mm width film on either round or square bales, there will be less joins on the wrapped bale, and wrapper output per hour will be considerably more than with 500mm film.

Film Application On Square Bales

Because square bales do not rotate so readily as round bales, it is especially important that the wrapper is correctly adjusted, and close attention should be paid to the advice given in the machine operator's manual.

Under no circumstances should film pre-stretch exceed 65% or less than six layers of film be applied to any part of the bale.

How To Wrap Correctly

Wrapping is one of the most important parts of successful baled silage production. Instructions issued by film and wrapper manufacturers should be closely followed.

For successful balewrapping the following points should be closely followed:-

- ☐ Always place the film reel on the machine so that on application the tacky outer film surface will face inwards towards the bale.

- ☐ For round bales, adjust the height of the pre-stretch unit to ensure that the centres of bale and reel are in line horizontally.

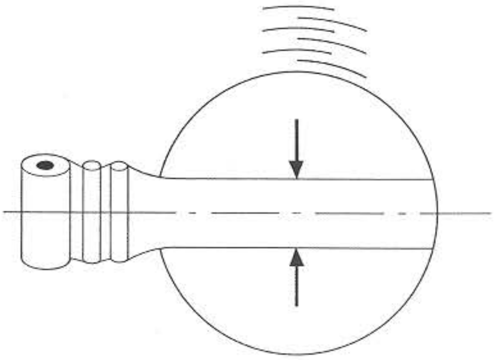
- ☐ Make sure that the wrapper is set for the film width in use.

- ☐ Apply six layers of film to all parts of the bale. For round bales, the wrapper can be calibrated by checking on the first bale, either manually or on the counter if fitted, the number of turntable or sweep arm revolutions needed to cover the bale once, then add one and repeat twice.

- ☐ Remember that even small differences in bale size and shape can result in variations in the number of revolutions and the amount of film required.

- ☐ Where square bales are being wrapped the machine should be calibrated according to the manufacturer's instructions.

- ☐ For round or square bales, stretch can be measured by placing two marks horizontally in line 10cm apart on the film reel. Then locate these marks as soon as they have been applied to the bale and measure the new distance between them. If 17cm, this indicates 70% stretch.



- ☐ On round bales, the degree of stretch can be checked approximately by measuring the film width on the flat ends of the wrapped bale. It should be no less than 400mm with 500mm film, or 600mm with 750mm film. The minimum overlap should be 200mm and 300mm with 500mm and 750mm films respectively.

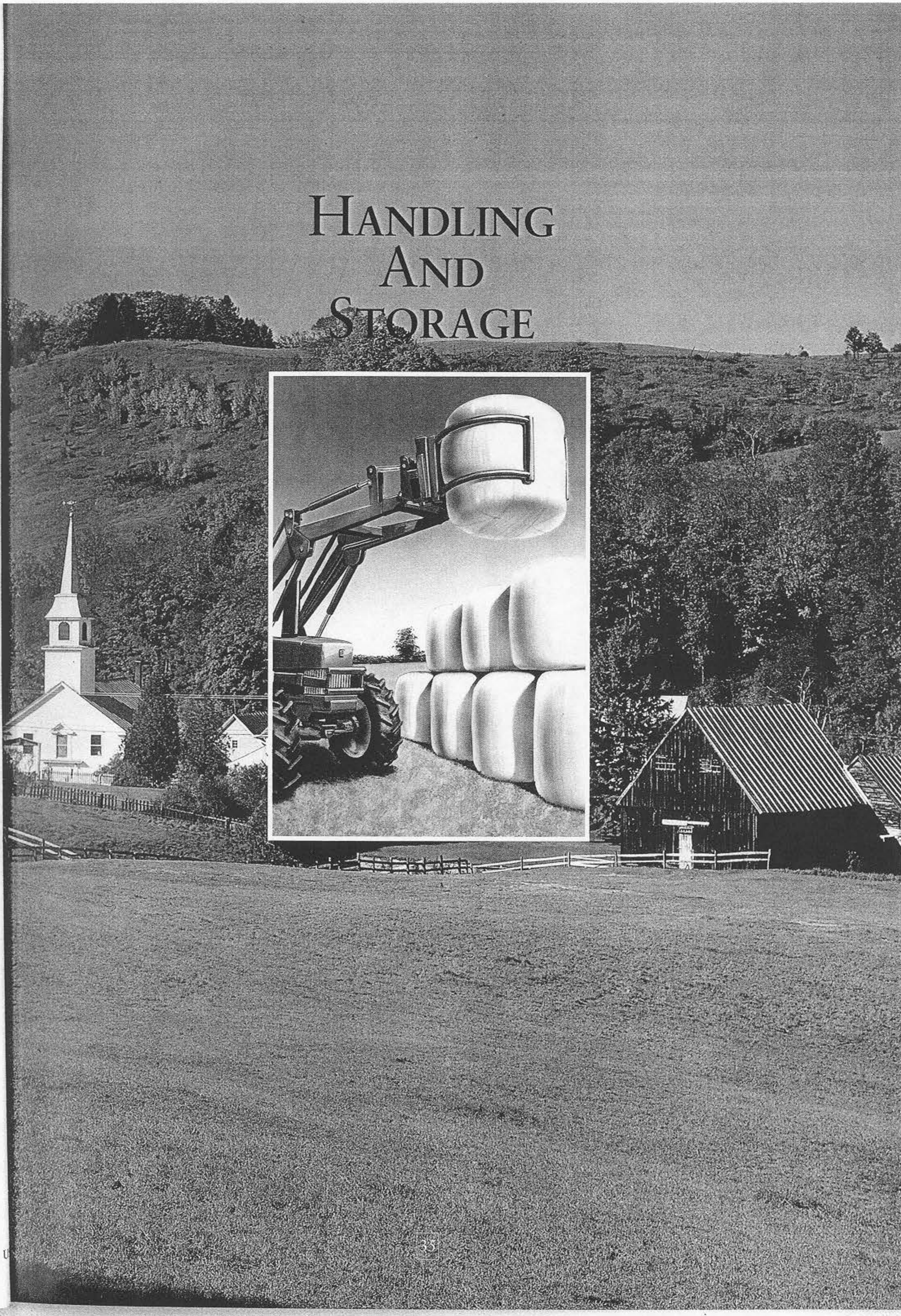
- ☐ Should any grass, twine or netwrap protrude between the layers during wrapping push back into the bale before continuing. Similarly, with any still visible on completion of wrapping, which should then be continued until a seal is achieved. If this is not done, air may enter between the layers.

- ☐ Never wrap in the rain. Water between the film layers can destroy the seal.

(see Checklist for more details).

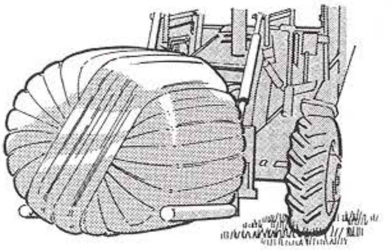
USA

Handling And Storage



The silage in the bale is valuable feed and care with handling and storage of bales is very worthwhile. Film must remain undamaged and tight.

Successful preservation of bales requires systematic planning. Remember that the overall thickness of 6 layers of film around the bale after pre-stretching will be only about 0.1 mm. It is therefore important to use a purpose-built handler which has as large a contact area with the bale as possible so that the film is placed under the least possible stress.



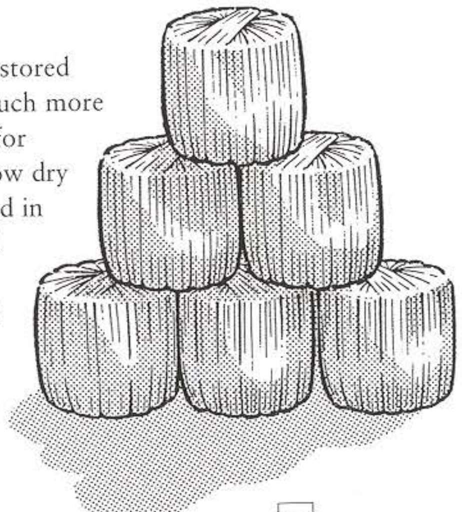
How To Handle The Bales

A good seal is achieved through each layer of film adhering to the next, and with careless handling, this seal can be broken, allowing air to enter the bale and cause spoilage. Best results are achieved when bales are wrapped at the storage point, which avoids unnecessary handling after they are wrapped. Good transport planning from field to storage point will help ensure that the operation progresses smoothly.

How To Store The Bales

Round Bales

Round bales are best stored upright, as there is much more film on the flat ends for protection. Bales of low dry matter should be stored in single layers, to avoid the heavy pressures exerted on the seal of lower bales if they are stacked.



Square Bales

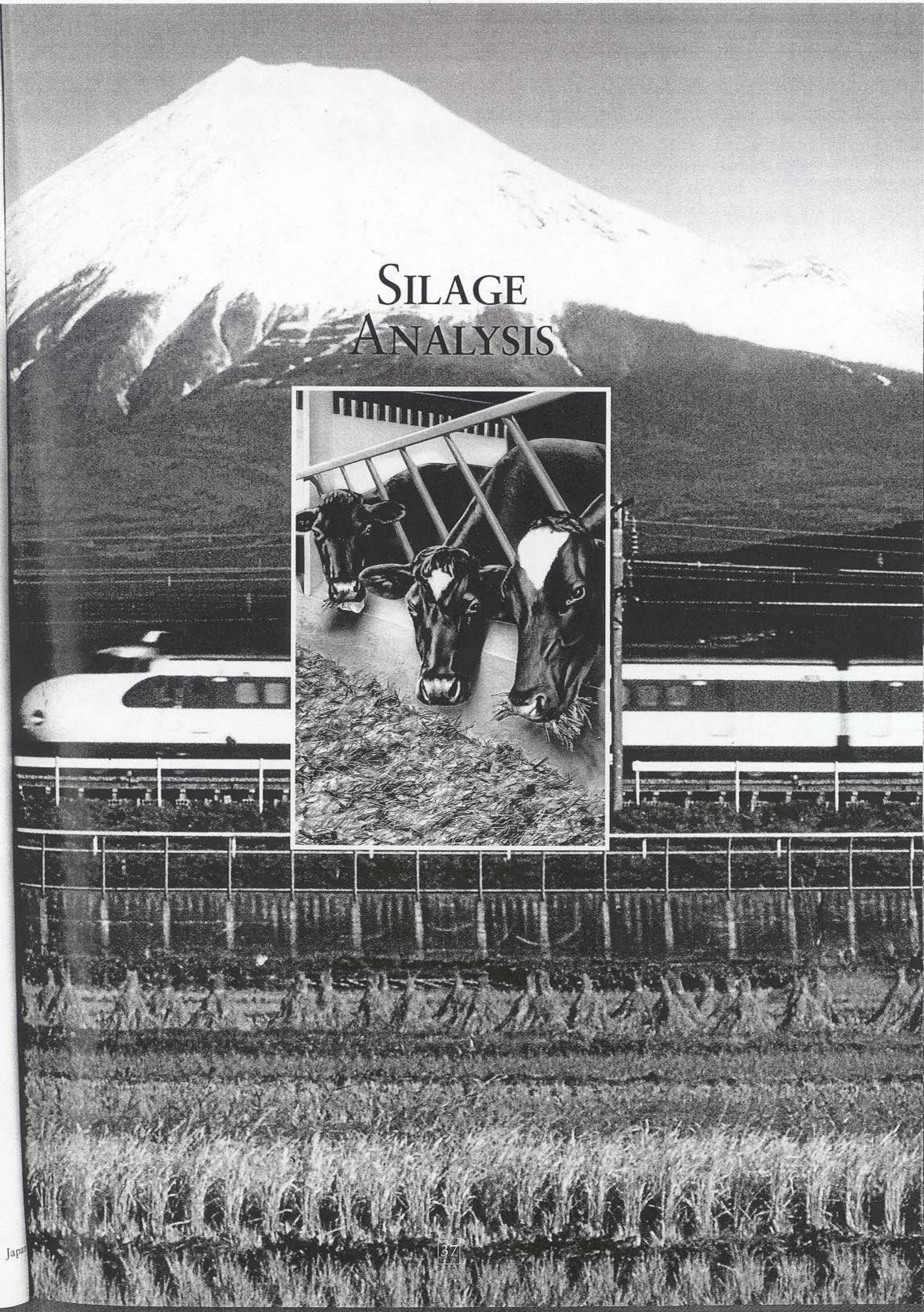
Wrapped square bales should be handled only with purpose-built equipment, in order to avoid damage to film. Stacking should take place immediately after wrapping, and any bales which are "banana-shaped" should be stacked with the concave side facing downwards.

How To Protect The Bales

Bales must be protected against birds and other animals if the film is to remain tight and undamaged. A storage site away from trees should be selected and a bed of fine material such as sand should be used as a base. The bales should be protected by a close-woven polypropylene net, secured at ground level, or by twine stretched in all directions over the bales between posts. A fence should be erected around the site if farm animals are in the field. If bales have to be wrapped in the field, move them to the storage point immediately afterwards. Remember that bales left around the field are prone to wildlife damage, and in any case neat stacks of bales harmonise better with the surroundings.

Japan

Silage Analysis



In many countries, analytical facilities are provided by either agricultural universities, colleges or advisory authorities, who will carry out scientific analysis on silage samples.

Whilst the experience of many farmers will enable them to make a basic assessment of the quality, dry matter content and likely palatability of wrapped silage on opening the bales, an accurate picture of nutritional values can only be formed from the results of laboratory analysis.The results of such analysis form the basis for the efficient use of wrapped silage. This can often also help to explain what may have gone wrong when poor results have been achieved, and this should always be used in conjunction with other possible contributory factors such as timing of manure application and harvesting, weather conditions, crop etc, in making a final judgement.

It is important that each sample is representative of the whole bale and is not less than 2-3kg in weight.

If possible, more than one sample should be taken, from several bales, though this may prove costly. It is also important that the sample is sealed in an airtight plastic bag immediately after removal from the bale, excluding as much air as possible before sealing. The sample should be kept in dark, cool conditions, and delivered with minimum delay to the laboratory, as any prolonged delay will influence the final results. If it is necessary to store the sample overnight, it should be placed in a refrigerator.

However, if it is necessary to store the sample for a longer period, it may be frozen, but not if moulds are to be analysed. It is best to inform the laboratory of what information is required i.e. standard silage analysis, pH, volatile fatty acids levels, moulds identification, etc.

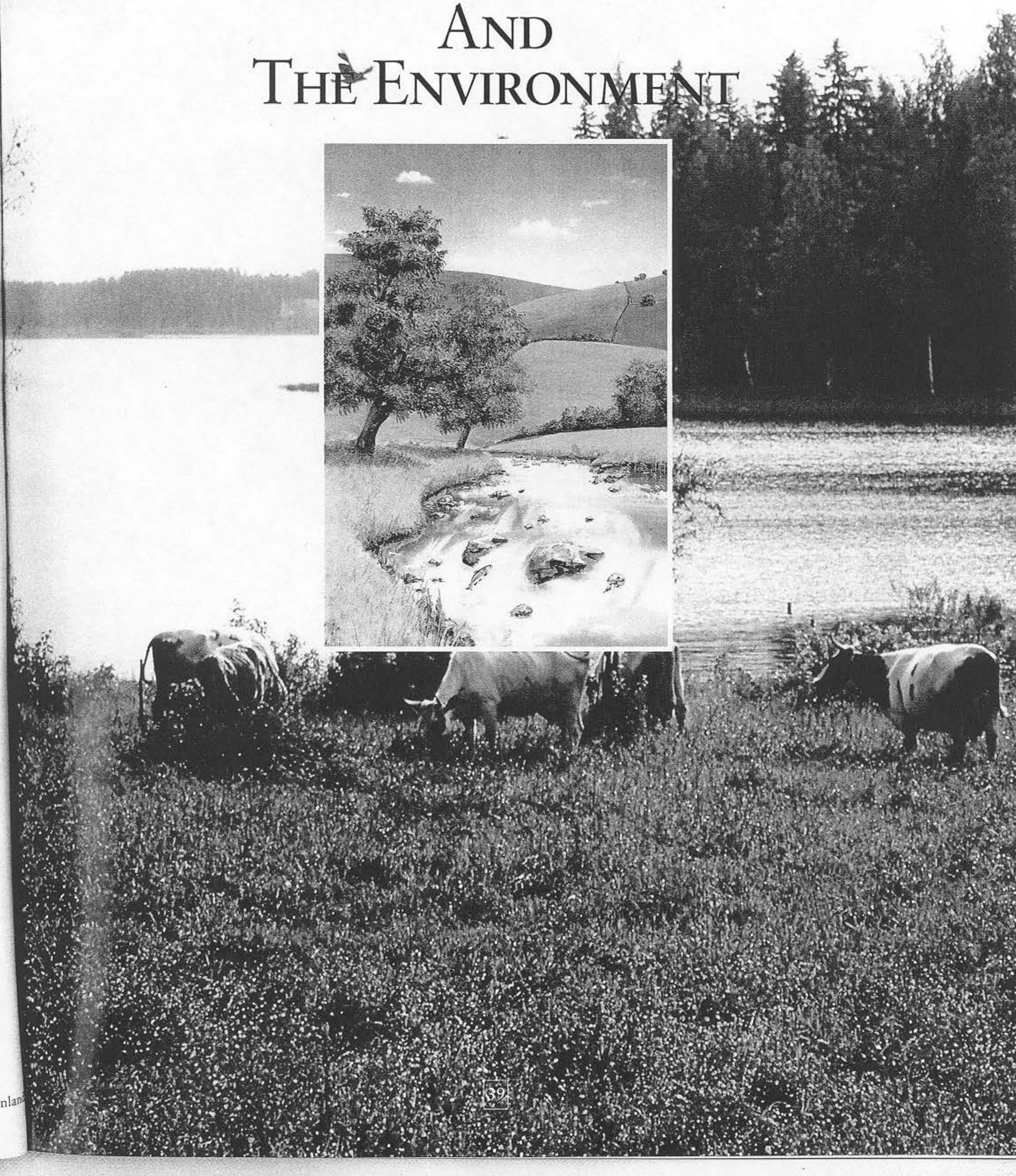
Table 6 below shows the typical information provided from standard analysis, and the values quoted would represent a well fermented silage of good quality and nutritional value.

Table 6

Wrapped Silage Sample (English rye grass)	
Dry matter (DM)	46
pH	4.6
Total crude protein %	14.6
Ammonia N% total N	12.3
Butyric acid%	0.02
Ammonia as crude protein %	1.8
Neutral detergent fibre %	57.1
Total ash %	6.8
Digestibility (D value)	67
Metabolisable energy (ME)	10.8 MJ/kg DM
Digestible crude protein (DCP)	106 MJ/kg DM

See Glossary for explanation of terms.

Silage Balewrapping And The Environment



The rapid growth in the popularity of silage balewrapping has meant that large numbers of wrapped bales are now stored in stacks, both large and small, around the countryside.

Stacks of bales have resulted in what some might regard as an environmental problem, in terms of a minor change in the appearance of the landscape, and for this reason it is very important that farmers give careful consideration to their choice of storage area, in order that the bales are as inconspicuous as possible.

Compared with bulk stored silage in clamps or pits, there is little danger with wrapped silage that any liquid will escape to pollute streams and watercourses, particularly if simple and cost-free regulations, where applicable, are adhered to. In the event of leakage of effluent from bales of low dry matter, the volume is likely to be extremely small, and usually only from the bottom layer, if the bales are stacked. Also, because bales are often stored on a large ground area, any leakage will simply disperse harmlessly into the soil.

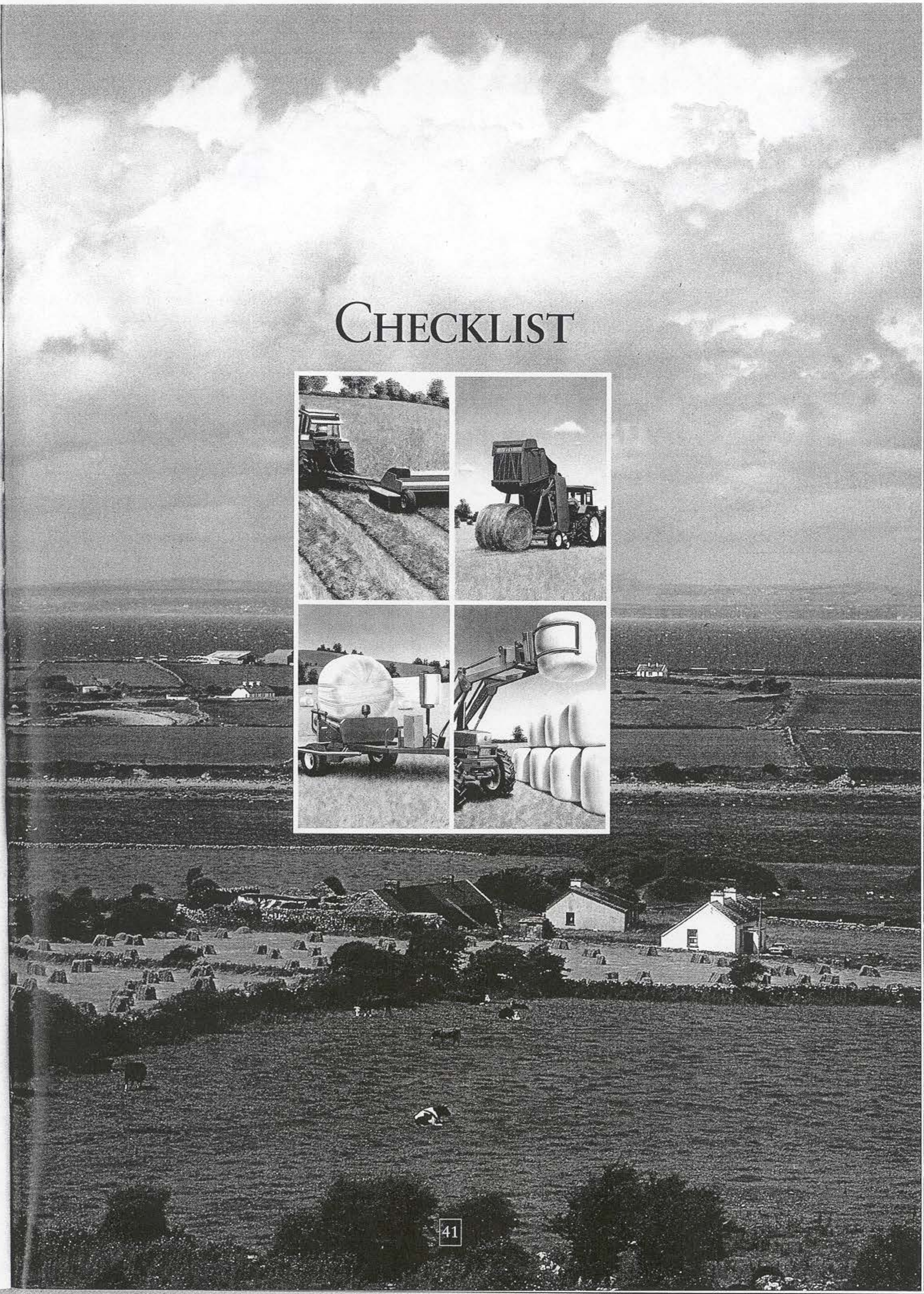
In contrast, the considerable weight of silage in bulk stores, and the fact that this weight is usually on a concrete base and concentrated in one area, often results in the leakage of very large volumes of effluent. Losses from clamps and pits are generally at least 20%, and extensive surveys have regularly found this figure can in fact average 30%, with extremes even higher.

Polyethylene balewrap film is in itself an environmentally friendly material with a high energy content. During controlled combustion, e.g. if used as a biofuel, it produces carbon dioxide, water and heat. However, when incinerated in the wrong way with insufficient oxygen, it produces the toxic gas, carbon monoxide.

From an environmental point of view, therefore, used balewrap film should ideally be stored and collected for use as an energy resource or biofuel. The uncontrolled burning or burying of such material on farm cannot be considered an environmentally friendly practice and is not recommended.

Plastic cores from the centre of balewrap reels are in many cases manufactured from recycled material. They have an advantage over cardboard cores in that if collected they can be re-used.

CHECKLIST



1. Achieving The Best Crop

- ☐ Take soil samples for analysis to check conditions of crop production.
- ☐ Apply any fertilisers, manure or slurry at least 6 weeks before mowing and before growth commences.
- ☐ Roll fields for mowing in the spring, to avoid soil contamination of bales.

2. Harvesting/Cutting

- ☐ Choose dry, sunny conditions.
- ☐ Avoid damp, dull days.
- ☐ Set cut height of mower conditioner at 8-10 cm to avoid soil and old straw heaps, etc.
- ☐ Cut grasses in early boot stage, and clovers at about quarter bloom.
- ☐ Wilt for 24-36 hours, depending on conditions, ideally to 45-50%.
- ☐ Produce even, flat-topped swaths to match machine type. Pointed swaths will mean uneven moisture loss.
- ☐ Do not make swaths too large, as this delays moisture loss.

3. Baling

- ☐ Make dense bales of identical size and shape.
- ☐ Remember that driving technique can affect bale density and shape.
- ☐ Do not use impregnated sisal twine.

4. The Film

- ☐ Store reels upright, in cartons, in cool dry conditions.
- ☐ Ensure that the film has reached ambient temperature before use.
- ☐ Remove from cartons only immediately before applying to wrapper.
- ☐ Handle carefully to avoid damage, particularly to reel edges.

5. Wrapping

READ THE FILM AND MACHINE MANUFACTURERS INSTRUCTIONS FIRST!

- ☐ Always choose a proven, high performance balewrap film.
- ☐ Use white film where bales will be exposed to prolonged and very intense sunlight.
- ☐ Make sure wrapper is set for width of film which is to be used.
- ☐ Place film reel on wrapper so that the tacky outer surface of the film will face inwards towards bale.
- ☐ For round bales calibrate wrapper on first bale to apply six layers by checking number of turntable or sweep-arm revolutions required to cover it once, then add one. Repeat this number of revolutions twice more. Remember that pre-set automatic machines assume all bales are identical - often they are not!

  To calibrate square balewrappers, consult manufacturer's instructions
- ☐ Check regularly that all parts of wrapper are working correctly and are lubricated where necessary, in particular the pre-stretch unit.
- ☐ Keep pre-stretch unit rollers clean and free of tack build up, as recommended by manufacturers.
- ☐ Wrap within 2 hours of baling, if possible at storage site. Misshapen round bales which are left for long periods will be more difficult to wrap and will need more film.
- ☐ Check the degree of stretch by placing two marks horizontally in line 10cm apart on the film reel. Then locate these marks as soon as the film has been applied to the bale, and measure the new distance between them. A distance of 17cm will indicate 70%

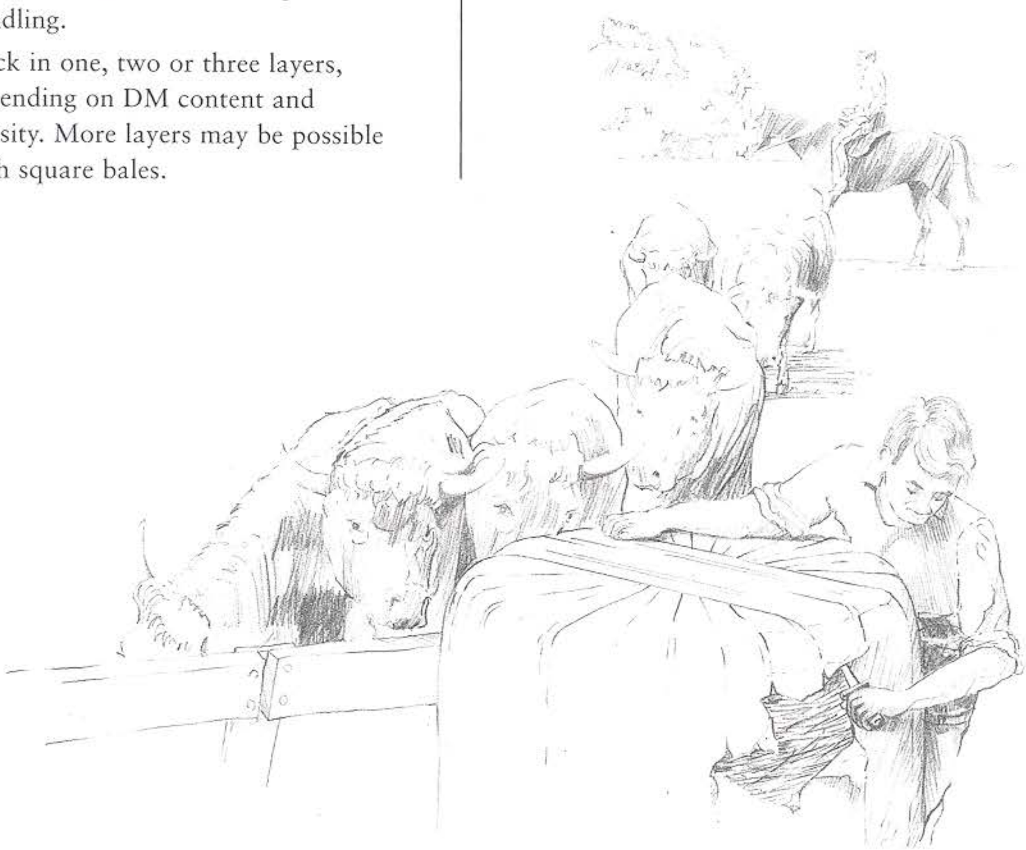
stretch. This method can be used when wrapping either round or square bales.

IF OVERSTRETCHING HAS OCCURRED, STOP WRAPPING AND FIND CAUSE BEFORE CONTINUING.

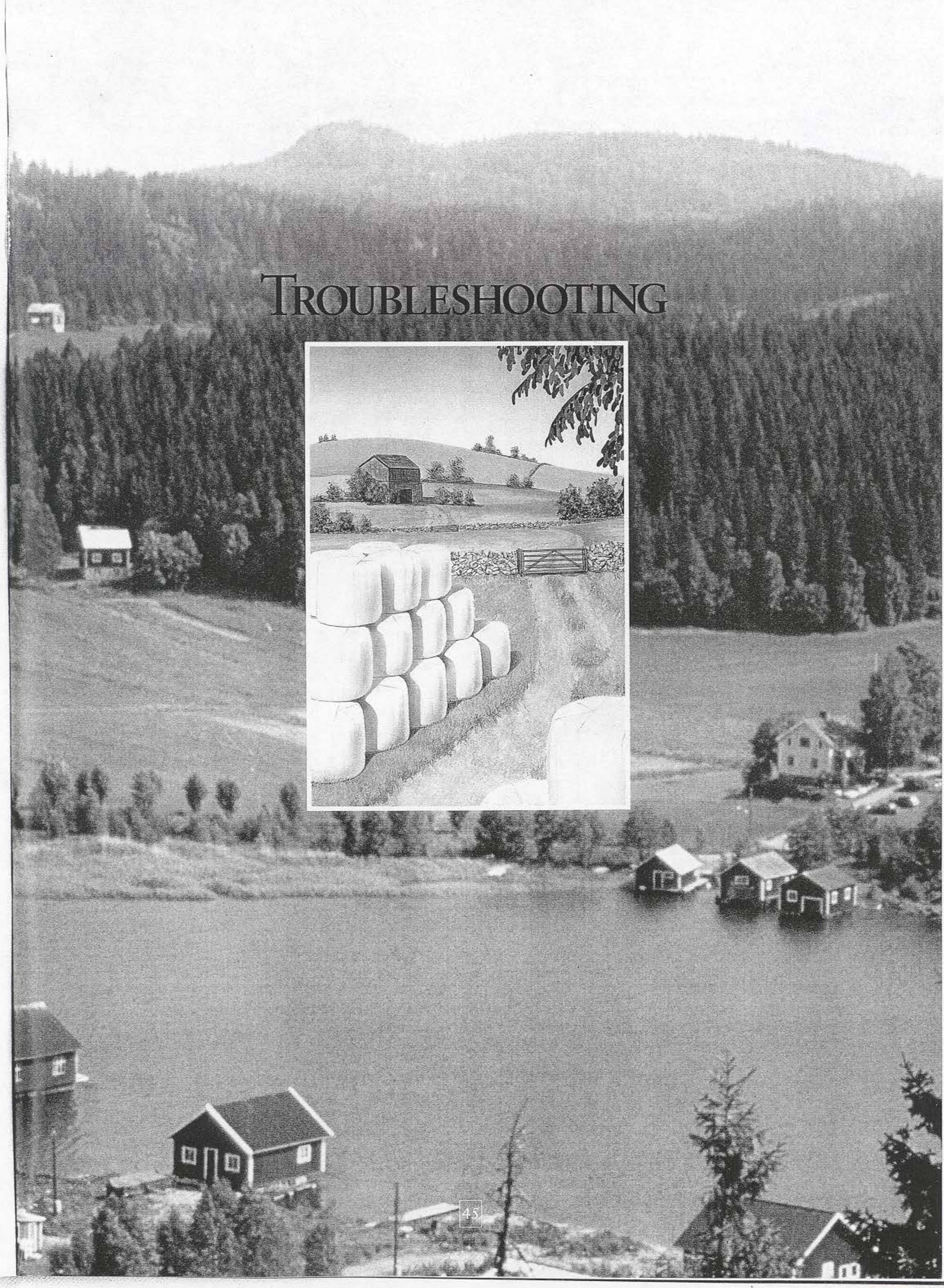
- ☐ Despatch bale from wrapper carefully to avoid damage.
- ☐ Secure cut end of film on bale.

6. Handling And Storage

- ☐ Choose storage site away from trees and not too close to hedges.
- ☐ Prepare a well drained site using a fine surface material (e.g. sand), to avoid damage to film by sharp objects.
- ☐ Place bales in storage area immediately after wrapping, using a purpose built handler. Round bales should be stacked on their flat ends. Any "banana-shaped" square bales should be stored concave side downwards. **Do not use a bale spike.**
- ☐ Avoid damage to film during handling.
- ☐ Stack in one, two or three layers, depending on DM content and density. More layers may be possible with square bales.
- ☐ Apply a close-woven polypropylene silage net to bales, securing at ground level, or apply twine at close intervals above stack, stretched between poles, to protect against birds.
- ☐ Erect fence around stack to prevent access by farm livestock, and other animals.
- ☐ Check bales regularly and repair any damage without delay using a purpose made UV-stabilised patching material.



TROUBLESHOOTING



The steady improvement in machinery and techniques means that silage balewrapping can now be a trouble free operation. Those problems which do occur usually fall into the following categories:

- ☐ the wrapping operation
- ☐ handling and storage
- ☐ silage quality

1. Problems During Wrapping

Overstretching

A typical sign of film overstretch is an undue narrowing of film width.

Film should be stretched within the range 55 - 70%. Most balewrappers are designed to work within this range. The final film width should be no less than 400mm with 500mm film, or 600mm with 750mm film. If film has been reduced much beyond these limits, it will have been weakened and the amount of overlap of layers will have been reduced, both of which can put the silage at risk.

The most likely causes of overstretching are either a worn or unlubricated pre-stretch unit, or an incorrectly adjusted film reel braking device, on the few machines which use them. Another contributory factor may be the build up of 'tack' from the film on the pre-stretch rollers, which should be frequently and thoroughly cleaned in accordance with machine manufacturer's instructions.
The pre-stretch unit is a precise and most important part of the balewrapper, and close attention to its maintenance is vital. Another reason can be excessive operating speed, which results in brief periods of overstretch immediately after each bale edge. This effect would be accentuated in high temperatures. Wrapper manufacturers' instructions regarding operating speed should not be exceeded.

Tearing/Holes In Film

This is usually caused by the reel having been damaged, in particular on the ends. Even the slightest damage can cause problems, possibly resulting in the film tearing during application. Great care should be taken with storage and handling of film reels, which should be left in cartons until they are placed on the balewrapper. Reels are removed more easily without damage from cartons which are designed to open from the side rather than the ends.

Film Layers Not Adhering

Although a rare occurance, if the layers of film are separating after application, a low film tack level may be indicated. This may be further confirmed if the normal 'crackling' sound which the film makes during wrapping is absent. In this case, change the reel and apply sufficient extra film to the bales involved to achieve an adequate seal.

2. Post Wrapping Problems

Splits In Film

Splits in film, when they occur, usually appear along the side of the bale, often through all film layers.

A high quality balewrap film, correctly applied in the recommended number of layers, is not likely to split in this way. In the majority of cases, splits are caused either by insufficient film having been applied, or by overstretching due to a faulty pre-stretch unit. In both cases, the wrapped bale will be more prone to handling damage because the overall cover of film has been weakened.

Fully automated round balewrappers assume that all bales are identical in diameter and perfectly shaped. In practice, this is often not so, and in many cases where film has split on wrapped bales, the splits are in the area of the bale just ahead of the last film to be applied. A check on the number of film layers at that point will often reveal that less than the required minimum are present, evidence that further turns of the wrapper were needed. A worn or poorly maintained pre-stretch unit is likely to overstretch the film, causing it to both narrow and thin unduly. This may be accentuated in hot conditions. The former can cause film overlap to be seriously reduced from the minimum 50% recommended, and film which has been overthinned will be weakened and more likely to give way under pressure.

Damaged Film

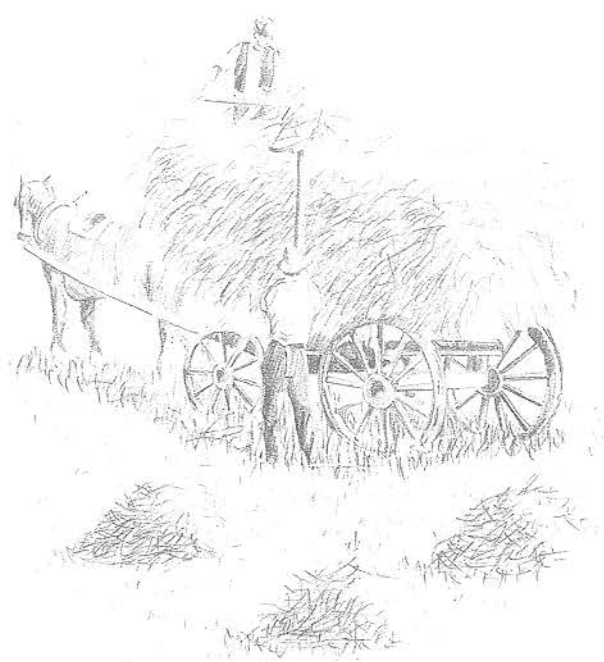
A large percentage of all damage to wrapped bales is that caused by animals. Much of it can, in fact, be avoided (see Handling and Storage).

Of all animal damage, that caused by birds is the most common. It is easily identified by the appearance of numerous holes, often of only 2-5mm diameter, mostly on the upper bale surfaces, where the birds can alight. The holes are usually through all film layers. Sometimes grass, twine or netwrap will have been pulled through the holes, and there may be bird droppings and/or footprints in evidence. On bales which have been wrapped in the field and left for a period before collection, there may also be bird damage close to the ground level.

Other animals, such as dogs, foxes, etc., are sometimes responsible for damage, which is easily identified by the presence of paw prints, tears/holes in the film etc. Unlike bird damage, these are often present on the sides as well as the tops of the bales.

Farm livestock, too, are sometimes responsible for damage to wrapped bales, which usually appears as sometimes quite large ragged holes in the film on the sides of the bales. Pieces of film may have been removed, and may be visible on the ground near the bales. Those bales on the outside of a stack will be most vulnerable. Stacked bales should be fenced to prevent access, and livestock should be kept away from fields from which bales have not been collected.

The effects of animal damage are frequently mistaken for film faults by the inexperienced observer. In the rare event of imperfections in a film reel, these will not show themselves in this way, because the 50% overlap system ensures that the chances of two or more faults coinciding on the bale are virtually nil.



Mechanical Damage

There are a number of possible causes, but the result is easily identified. Even purpose-built bale handlers can cause damage to film if sufficient care is not taken, and field-wrapped bales which have become misshapen through being left too long before stacking will be particularly prone to this, being more difficult to pick up. In addition to holes and tears, scuff marks and abrasions are also often in evidence.

Where bales are field-wrapped, the film can sometimes be damaged by stiff grass stubble when the bale is despatched from the wrapper, identified as pinholing on part of the circumference. Gentle despatch onto the ground will help reduce this problem.

Water In Bales

An accumulation of water in the bottom of a wrapped bale during storage can indicate that the film has either been damaged or incorrectly applied, allowing rain to enter. This is sometimes seen as a 'blister' in the film on the underside of the bale when it is removed from the stack.

If such water is present and neither of the above causes are indicated, it is likely to have been caused by condensation. In particular with black film, there can be a considerable difference between the temperature inside the bale during day and night resulting in condensation, which can accumulate over a prolonged period. There is of course a limit to the volume of this water from condensation which can cling to the inside of the film, and it will eventually run down to the bottom of the bale. The volume can be surprisingly large. (See Table 5, page 28) In such cases, the silage quality is often unaffected.

However, it should be remembered that water is also produced by moulds, which may give the impression of a high moisture level.

Leakage

Occasionally, where bales are of low dry matter and are stacked, there may be leakage of a small volume of silage liquor from between the film layers of the bottom layer of bales. This is accentuated by pressure from bales above, and can be largely avoided by storing bales of low dry matter in single layers only.

However, where leakage does occur, liquid volume should be small, and provided the bales are not close to watercourses, will disperse into the soil without problem. It should be noted that although liquid can seep out of wrapped bales, this does not allow air back in. This is because the stickly nature of the silage liquor will re-seal the film layers after seepage has ceased.

3. Silage Quality Problems

The handbook covers all the important aspects of good crop-husbandry prior to mowing for big bale silage. If these are not closely adhered to, the resulting silage bales may prove of poor feed value, or may even suffer varying degrees of spoilage, rendering them unsuitable as feed for most stock.

Secondary Fermentation

When the original fermentation is incomplete and fails to establish sufficiently high acidity to stabilise the bale, a second fermentation will occur which involves the loss of lactic acid, and an increase in butyric acid.

Silage from bales which have suffered secondary fermentation is likely to have a slimy green/brown appearance, and has a characteristic strong and unpleasant odour. It is usually of poor palatability.

Poor preservation and palatability can also result from the incomplete utilisation of fertilizer by the grass as a result of cold conditions during the early part of the season, and the consequent increased crop content of nitrates and ammonia nitrogen. For this reason, applications of fertiliser should be made at least six weeks prior to mowing.

Yeast And Moulds

To prevent fungal growth, it is essential to handle the crop with care. Long wilting periods allow fungi time to grow. Moulds do not grow in the absence of oxygen. Therefore a dense bale, free from contamination and wrapped within a short period after baling will prevent aerobic deterioration, temperature increase and fungal growth.

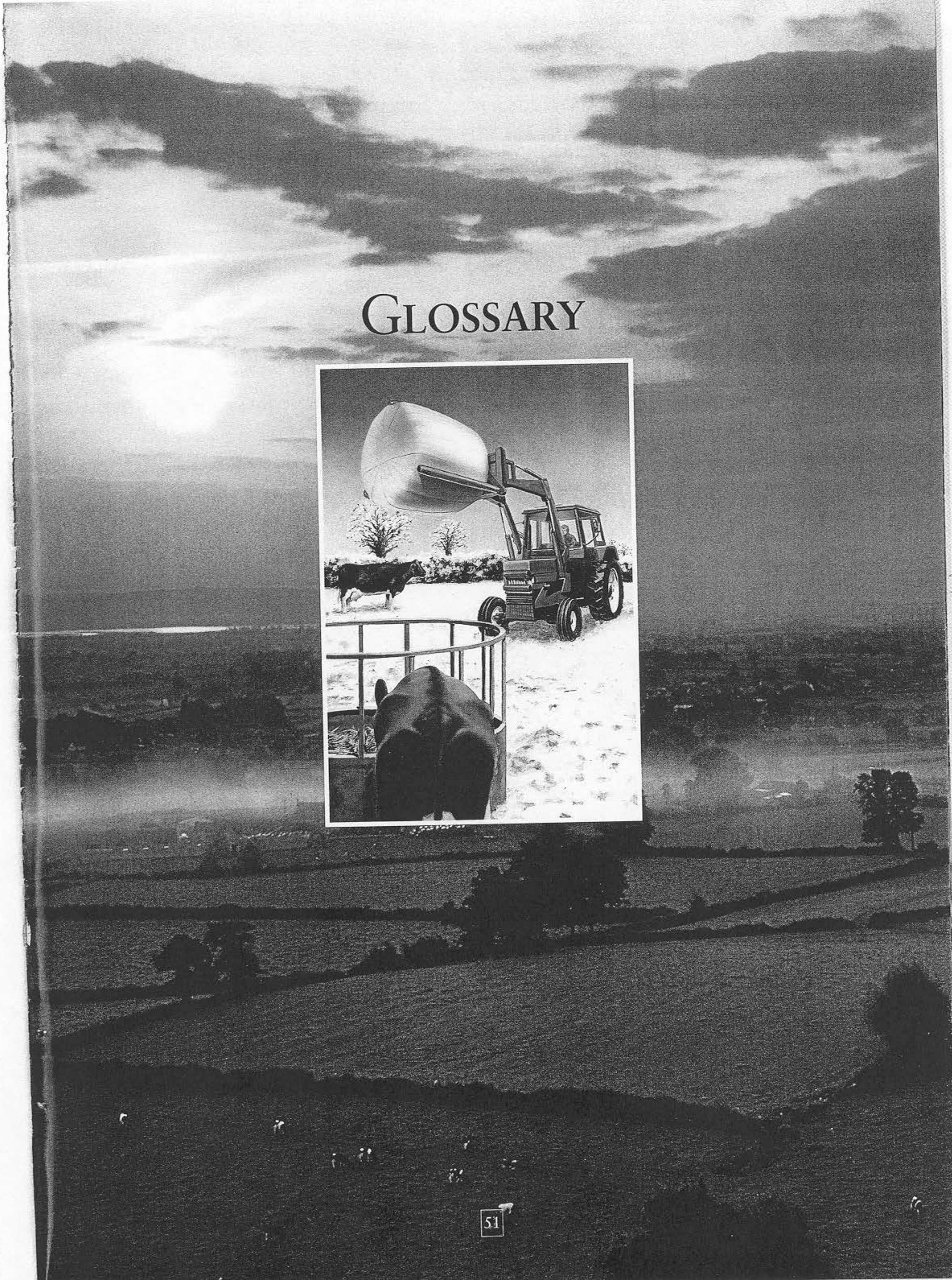
Longer wilted crops are likely to have a higher sugar content but will also contain more oxygen if not baled sufficiently densely. In airtight bales, however, the rapid consumption of oxygen and lack of water decrease the likelihood of fungal growth.

Most mould problems occur in late cut crops and bales of low density, and also if the stretchfilm around the bale is not sufficiently tight, when there are likely to be air spaces inside the bale. This is particularly likely when bales are of uneven shape. The pressure inside bales will vary during the day, and when it drops there is a likelihood that oxygen may be drawn in from outside.

When wrapping, it is essential that no grass lies between the film layers, which will allow air leakage. The resulting moulds are usually seen as soon as the film is removed from the bale.

Correct pre-stretching and degree of overlap is vital in order to prevent oxygen leakage. The application of 6 layers and the use of white film will decrease the problem. Never use a spike to move the bale except at feeding time. It is not possible to seal a spike hole adequately with tape!

GLOSSARY



AEROBIC BACTERIA
Bacteria which thrive in the presence of oxygen.

AMMONIA AS CRUDE PROTEIN
Ammonia concentration of silage.
The concentration of ammonia is a result of protein breakdown, often caused by undesirable bacteria growth

AMMONIA N (as a percentage of total nitrogen)
This figure gives a good guide as to how successful the fermentation was, and the extent of protein breakdown to ammonia. The lower the figure the better.

ANAEROBIC BACTERIA
Those bacteria which only grow in the absence of oxygen. Examples are Clostridium Tyrobutyricum which causes quality problems in cheese, and Clostridium Botulinium which produces the particularly harmful poison Botulin.

BUTYRIC ACID
The acid produced during fermentation by the action of clostridia, and which is responsible for the rancid, strong smelling nature of the resulting silage.

CLOSTRIDIA
Undesirable micro-organisms, which compete with the lactic acid producing organisms for plant sugars. They thrive in the absence of oxygen, and particularly in wet silage.

D VALUE
A measure of the digestibility of the silage. The main influence on this is the stage of growth of the crop when harvested.

DIGESTIBLE CRUDE PROTEIN (DCP)
The portion of the total protein content which is digestible. Desirable values range from around 90g/kg DM for sheep and beef cattle, up to about 120 g/kg DM for dairy cows.

DM (DRY MATTER)
The percentage of dry matter in the crop which in turn indicates its moisture content. For wrapped silage, the DM should ideally be 45 - 50%.

FERMENTATION
The natural process which occurs during successful silage production whereby lactic acid organisms ferment carbohydrates to organic acids, resulting in the stabilisation and preservation of the bale.

FILM OVERLAPPING
The degree of covering of one film layer over the previous layer. This should be a minimum of 50%.

LACTIC ACID
The strongest organic acid produced during a successful fermentation, and one which makes the biggest contribution to acidification/preservation.

LACTIC ACID BACTERIA
The organisms which produce lactic acid as their end product, and on which good fermentation relies. They grow best in the absence of air.

METABOLISABLE ENERGY (ME)
This is expressed as megajoules per kilogram of dry matter, and is a most valuable indication of the energy value of the silage, particularly when formulating rations. It is related to digestibility and fibre content. Target figure should be in excess of 10.0Mj/kg DM

NEUTRAL DETERGENT FIBRE
This refers to the fibre content of the sample, and must be taken into consideration when deciding on feeding regimes.

pH
This is an expression of the degree of acidity, and an indication of how successful fermentation was. As an example, pure water has a pH of 7, and the lower the pH figure, the higher the acidity. Thus, a silage with pH of 4.0 is likely to be better preserved than one with a pH of 6.5. Organisms which cause spoilage do not thrive in highly acidic conditions. pH is also related to the DM content.

PRE-CUTTING
The relatively new technique of cutting the grass into shorter lengths on entry to the bale chamber, in order to facilitate release of plant sugars, and as an aid to better bale density. It also makes feeding easier.

PRE-STRETCHING
This term refers to the pre-stretching of the film by the balewrapper prior to its application to the bale. It is achieved by passing the film over two rollers, the second of which is rotating faster. It is expressed as the percentage increase in length, and should be in the range 55-70%. A small degree of secondary stretch is applied by the force exerted on the film by the rotating bale. (Approximately 10%)

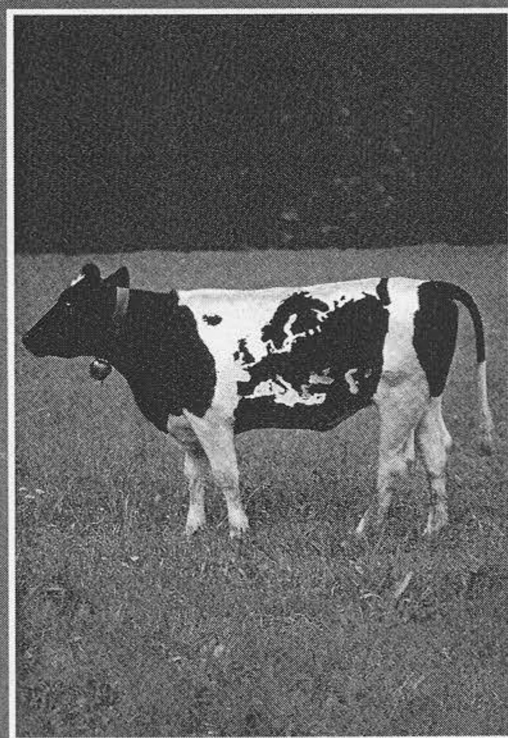
SECONDARY FERMENTATION
This occurs when the original fermentation fails to achieve sufficient storage stability within the bale, and negative bacteria convert lactic acid to butyric acid and degrade proteins. The usual result is a strong smelling unpalatable silage of poor digestibility.

TACK
A feature of high quality stretchfilm which ensures a good seal between film layers.

TOTAL ASH
This is a measure of the content of mineral matter, which would be influenced by for example soil contamination. Figures over 12% demonstrate unacceptably high contamination.

UV
The ultra-violet fraction of sunlight which will degrade unprotected film. Good quality stretchfilm designed for balewrapping has in-built protection for 12 months.

WILTING
The process by which the crop is dehydrated in the field prior to baling in order to concentrate plant sugars, and reduce or halt the growth of those bacteria which cause spoilage.



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