Eco-friendly hay drying with the AGRIFRIGOR™ process (dehumidifiers)

by Ralph E. Kolb

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Hay is one of the most important types of fodder for animals such as cattle, horses, sheep, goats and camels. Thousands of dairy farmers depend on good milk quality and quantity for their business success. That requires high feed quality. Every year, tons of poor-grade hay are produced that are unsuitable as fodder and can only be used for litter. In times of steadily increasing concentrated fodder prices, especially for protein concentrate, hay quality is a major economic factor. That also applies to stud farms.

Top hay quality with AGRIFRIGOR™

The weather is and remains a crucial factor in the production of hay. But changeable weather is becoming ever more frequent. That is why plants for drying hay by means of dehumidification are indispensable today. They enable farmers to plan with confidence and ensure good quality. The AGRIFRIGOR™ process dries hay to top quality whatever the weather:

- Barely any losses from crumbling and respiration.
- Rapid drying to a value required for stable storage prevents growth of fungus and bacteria (4).
- Reduced risk of combustion that can occur with insufficiently dried hay. This ensures animals get good, healthy fodder and cattle produce high-quality milk and meat.

Other factors for good hay quality

- Haymaking
  Apart from choosing the ideal mowing time, a good meadow with grasses, clover and meadow herbs is the most important basic requirement for good hay quality with a high protein content and energy density (2). During haymaking in the field, optimal tedding and swathing are essential. That applies to the time chosen as well as the speed or rate of turning. It is also important not to cut too deeply. All this significantly reduces feed soiling and losses.

If a farm has a machine drying system with a dehumidifier, it can mow or harvest up to 20 days (2) earlier. These farms are efficient and can take advantage of short windows of sunshine for wilting.

Haymaking / crumbling losses (19)

Haymaking involves drying in the field, on racks or using machines. Rack drying is labour-intensive and therefore rarely used today. Traditional field drying comes with a number of drawbacks (e.g. crumbling losses and/or fungus). However, the main problem is changeable or damp weather. Farmers cannot rely on sunny days during the required periods. However, they can produce first-class hay cost-effectively and independently of the weather with machine drying using dehumidifiers.

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Water content [%]          Date
[Graph showing moisture development during field drying]

1. Moisture development during field drying

Comparison of hay drying methods

Experts at the Agricultural Teaching and Research Centre (LFZ) Raumberg-Gumpenstein in Austria conducted a project to examine three different methods of drying hay:

- Traditional field drying
- Cold aerating (only one fan)
- Dehumidifier drying combined with under-roof extraction (under-roof preheating or solar preheating).

The challenge of crumbling loss

Significant crumbling losses occur during field drying of fodder plants, especially legumes (alfalfa, clover). This is due firstly to machine handling (plant parts are torn off) and secondly due to the degree of drying. The crumbs fall to the ground between the stubble where machines such as bale presses or loaders cannot pick them up. Round bale pressing creates an additional crumbling loss of up to 2.4%. The dropped plant parts (leaves, buds etc.) contain important nutrients. The fodder quality depends substantially on the energy value and content of minerals and effective substances. High values result in high basic fodder quality and therefore good milk yields and animal health. Crumbling losses are low when the hay is transported to a drying box when it has a dry matter content of over 60%.

Table 1: Net dry matter yield, determined in Austrian meadowland (8)

<table>
<thead>
<tr>
<th>Type of use</th>
<th>Net DM yield (ha/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single cutting areas</td>
<td>3 – 4.5</td>
</tr>
<tr>
<td>Double cutting areas</td>
<td>4.5 – 5.5</td>
</tr>
<tr>
<td>Triple cutting areas</td>
<td>7 – 8</td>
</tr>
<tr>
<td>Multiple cutting areas</td>
<td>8.5 – 10.5</td>
</tr>
</tbody>
</table>

Best test results:

Dehumidifier drying

The project demonstrated among other things that dehumidifier drying produced an average of 5 g more raw protein in the dry matter than field-dried hay. Furthermore, dehumidifier drying produces more dry matter, more net-energy lactation and better digestibility of the organic matter than the two other methods.

The AGRIFRIGOR™ process – advantages:

- Weather-independent
- Low crumbling and respiration losses
- Low fungus infection
- Significantly lower fire risk
- Higher protein content, more dry matter, more net-energy lactation, better digestibility
Another important advantage of dehumidifier drying is lower fungus infection. As part of the study by the LFZ Raumberg-Gumpenstein, the Agency for Health and Nutritional Safety Linz (Austria) carried out microbiological tests (2). These tests established that fungus proliferates more rapidly in hay dried in the field than in machine-dried hay. Fungus types such as Aspergillus glaucus and Wallemia sebi can spoil hay within a short time. They are indicated by dustiness and a musty odour.

Hay – different regions, different terms
Usually, the first mowing is termed haymowing. (Haymaking = mowing of grass which is dried to make hay) The second mowing is termed Øhmd, Grummet, Emd or Ettgrön in German. The second mowing is termed Öhmd, Grummet, Emd or Ettgrön in German. All subsequent mowing operations are termed third mowing, fourth mowing and so on. Special terms for the third mowing are only used regionally, e.g. in the Salzburg region “Woad”, in the Erzgebirge Mountains “Zweite Schur” and in the Tyrol region “Pofel”.

Evaluation of hay quality
The Bavarian State Research Centre for Agriculture (LfL) (16), defines first-class hay as having the following properties:

- Olive-green colour (light to dark green)
- Aromatic smell (no necrotic smell, no smell from external sources, no musty smell)
- Leaf content (according to the original material)

Smell, colour and structure of the hay are evaluated by means of a sensory examination. To evaluate the degree of preservation success, the experts started with the assumption of top fodder quality of the mown grass and deducted points after the evaluation.

<table>
<thead>
<tr>
<th>Use stage 1st growth</th>
<th>Energy concentration of the green fodder (16)</th>
<th>[MJ/kg DM] in green fodder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use stage 1st growth</td>
<td></td>
<td>[MJ/kg DM] in green fodder</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ME*</td>
</tr>
<tr>
<td>Leaf stage</td>
<td></td>
<td>11.6</td>
</tr>
<tr>
<td>Shoots</td>
<td></td>
<td>11.2</td>
</tr>
<tr>
<td>Ears, panicles</td>
<td></td>
<td>10.65</td>
</tr>
<tr>
<td>Start of flowering</td>
<td></td>
<td>10.1</td>
</tr>
<tr>
<td>End of flowering</td>
<td></td>
<td>9.75</td>
</tr>
<tr>
<td>Follower growth age</td>
<td></td>
<td>10.7</td>
</tr>
<tr>
<td>Shoots 4 – 5 weeks</td>
<td></td>
<td>10.5</td>
</tr>
<tr>
<td>Ears, panicles 6 – 8 weeks</td>
<td></td>
<td>10.1</td>
</tr>
<tr>
<td>Start of flowering &gt; 8 weeks</td>
<td></td>
<td>9.7</td>
</tr>
</tbody>
</table>

* If the share of fine-leafed/coarse stemmed grasses/herbs is high, add or subtract 5%.

Energy concentration of the green fodder (16)

3 Influence of different drying methods on the dry matter content DM [2]

4 The difference between various drying methods on the development of the mould fungus Aspergillus glaucus [2]

The benefits for farmers of machine drying:
- Greater planning and quality assurance
- Better hay quality
- Better animal health
- Increased profitability of the farm

Energy content of hay as having the following properties:
- High milk and meat quality
- Increased profitability of the farm

5 Good hay

Points are deducted according to the following evaluations:

| Colour (examination for effects of precipitation and heat as well as mould) |
|-----------------------------|-----------------------------|
| Bleached or slightly browned | 2                           |
| Severely bleached or browned | 5                           |
| Visible mould               | 7                           |

<table>
<thead>
<tr>
<th>Smell (examination for mould infestation or heat effects)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bland or slightly necrotic smell or smell from external sources</td>
</tr>
<tr>
<td>Musty, stale or stronger necrotic smell</td>
</tr>
<tr>
<td>Severely musty or severely necrotic smell</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Structure (examination for incorrect mechanical treatment)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low leaf content (leaves still mainly present)</td>
</tr>
<tr>
<td>Very low leaf content (leaves partly present)</td>
</tr>
<tr>
<td>Almost completely stalks, straw-like</td>
</tr>
</tbody>
</table>

Quality deduction Grade Evaluation ME NEL

<table>
<thead>
<tr>
<th>Quality deduction</th>
<th>Grade</th>
<th>Evaluation</th>
<th>ME</th>
<th>NEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>very good</td>
<td>0.8</td>
<td>0.5</td>
</tr>
<tr>
<td>2 – 3</td>
<td>2</td>
<td>good</td>
<td>1.0</td>
<td>0.6</td>
</tr>
<tr>
<td>4 – 5</td>
<td>3</td>
<td>need for improvement</td>
<td>1.2</td>
<td>0.7</td>
</tr>
<tr>
<td>6 – 8</td>
<td>4</td>
<td>poor</td>
<td>1.4</td>
<td>0.9</td>
</tr>
<tr>
<td>&gt; 8</td>
<td>5</td>
<td>very poor</td>
<td>&gt; 1.4</td>
<td>&gt; 0.9</td>
</tr>
</tbody>
</table>

Evaluation of drying

Total points for value reduction* compared to green fodder in MJ/kg DM

<table>
<thead>
<tr>
<th>Qualification for aerobic hay drying</th>
<th>Value reduction* compared to green fodder in MJ/kg DM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality deduction Grade Evaluation</td>
<td>ME NEL</td>
</tr>
<tr>
<td>0</td>
<td>1 very good</td>
</tr>
<tr>
<td>2 – 3</td>
<td>2 good</td>
</tr>
<tr>
<td>4 – 5</td>
<td>3 need for improvement</td>
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<td>4 poor</td>
</tr>
<tr>
<td>&gt; 8</td>
<td>5 very poor</td>
</tr>
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</table>

* Values apply to field-dried hay, in the case of aerated hay, the losses are lower by 0.2 to 0.3 MJ NEL/kg DM

ME = metabolic (utilizable) energy
NEL = net-energy lactation
(lactation = milk production)

Additional quality impairment due to contamination

Vigorously shake hay over a light-coloured area, then examine the particles on the area. Green particles are leaf or stem particles, brown or black particles are contamination by soil.

Energy content of hay

<table>
<thead>
<tr>
<th>Quality deduction for aerobic hay drying</th>
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<tr>
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<tr>
<td>6 – 8</td>
<td>4 poor</td>
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<tr>
<td>&gt; 8</td>
<td>5 very poor</td>
</tr>
</tbody>
</table>

In green fodder (see separate table)

Quality deduction due to drying

Additional quality deduction due to contamination

Energy content of hay

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Source: Reinhard Resch

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Source: Reinhard Resch
Preliminary drying (witting) on the field is important (6)

Freshly mown green fodder has a water content of some 80%, which means a dry matter (DM) content of just 20%. After one day of drying in the sun on the field, the water content is still around 40%, therefore the dry matter content is 60%. With a dry matter content of 60% to 70%, the wilted grass can be transferred to a drying box or hay box.

Drying behaviour of meadow grass

Immediately after mowing, the openings (stomata) on the underside of the leaves close up, which slows the drying speed (8). Conditioners remove the wax layer on the fodder so that loose swathes can be produced. This increases the drying speed. Furthermore, this step eliminates an extra process with a tedder, which reduces crumbling and respiration losses.

Application fields for eco-friendly hay drying with AGRIFRIGOR™

In view of the large number of agricultural products, only the most important applications are described briefly here.

Alfalfa

Alfalfa belongs to the group of legumes and because of its high mineral and protein contents it is an important fodder plant, especially for horses. There is always a danger with alfalfa of high crumbling losses. This can be minimised with the AGRIFRIGOR™. It takes longer to dry alfalfa because the stalks are very thick compared to grass stalks. This must be taken into account in farm logistics.

Hops

The correct air velocity during hop drying is the prerequisite for optimum drying and high energy efficiency (11). Due to the varied density of hops, they dry unevenly if the air velocity is too high. This increases energy consumption because the air does not have time to absorb moisture as it passes through. On the other hand, if the air velocity is too low, drying time is increased and performance is lower.

Herbs and tea leaves

Herbs and tea leaves must be dried gently. Because of the low temperature differences between the drying air and the herbs, a heat pump is suitable for this.

Dairy farming

Good hay quality contributes to good milk yield and quality as well as significantly boosting animal health (17):

Hay encourages cows to ruminate.

Hay produces good eating behaviour in calves and a large rumen volume.

Hay protects against metabolic diseases.

Good hay does not require attractants such as molasses, which are banned in hard cheese manufacturing.

Better milk quality from top green fodder quality

The fodder quality is decisive for encouraging the animals to eat well. Each kilogram of hay can save up to 0.75 kg of concentrated feed (3). Hay does not contain fermented acids like silage, but it does have a higher content of ungraded proteins (UDP). Cows use undegraded crude protein (nXP) in their gut which is composed of the UDP which is not broken down in the rumen and the NPN (non-protein nitrogen) and/or ammonia which is broken down in the rumen. The animal’s small intestine can utilise both of these substances.

Sheep

Sheep require sufficient protein and energy in their fodder. Machine hay drying guarantees the high hay quality necessary for animal health and hygiene. Sheep should be given a little silage supplemented daily with protein and hay. They also need access to fresh water.
### Machine hay drying

**Hay**

Hay plays a key role in the normal daily ration for riding horses (with a body weight of around 600 kg). Hay should contain at least 20% raw fibre because this aids digestion. Because it takes a long time for a horse to consume its hay ration, this is an important pastime for horses in boxes. Good hay contains a low proportion of dust, which is extremely important with regard to allergies or general health for animals in boxes.

**Heat pumps (dehumidifying and heating)**

Heat pumps perform two work processes in hay drying:

1. The air is dehumidified in the evaporator. The water condenses and drains off through a condensate hose. Then the air is heated. This decreases the relative humidity by some 5% per degree C of heating.

2. A heat pump that dehumidifies and heats is very effective and achieves a high coefficient of performance (COP). COP describes the efficiency of a cooling unit or heat pump. It indicates the ratio of heat performance and electricity consumption under specific conditions. A heat pump can only be correctly evaluated on the basis of real values. Theoretical figures that state maximum achievable values are not likely to apply in practice and are therefore meaningless.

A hydraulic bypass is integrated in the cooling circuit which briefly increases the temperature in the cooling circuit (evaporator) if there is a risk of ice formation. AGRIFRIGOR™ automatically prevents ice formation so that the plant does not require permanent monitoring and does not need time-consuming defrosting. The total air flow can always be applied to the AGRIFRIGOR™ heat pump (dehumidifier). If only a partial flow (auxiliary flow) is channelled through the heat pump, an additional fan (auxiliary fan) may be necessary.

### Daily ration for a riding horse weighting 600 kg [DLO table]

<table>
<thead>
<tr>
<th>Feeder type</th>
<th>Quantity (kg)</th>
<th>Dry matter (g)</th>
<th>Digestible protein (g)</th>
<th>Energy M/DE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hay</td>
<td>9</td>
<td>4.3</td>
<td>270</td>
<td>60</td>
</tr>
<tr>
<td>Wheat straw</td>
<td>1.5</td>
<td>1.3</td>
<td>14</td>
<td>7.1</td>
</tr>
<tr>
<td>Oats</td>
<td>3</td>
<td>2.7</td>
<td>255</td>
<td>34.6</td>
</tr>
<tr>
<td>Barley</td>
<td>1.5</td>
<td>1.3</td>
<td>131</td>
<td>19.3</td>
</tr>
<tr>
<td>Carrots</td>
<td>2</td>
<td>0.2</td>
<td>18</td>
<td>3.3</td>
</tr>
<tr>
<td>Total</td>
<td>9.8</td>
<td>688</td>
<td>104</td>
<td></td>
</tr>
</tbody>
</table>

Note: M/DE = mega joule digestible energy (easily digestible energy)
Exhaust
Air
Recirculating
flap

The control system
A hay drying system can be operated with a simple control system and manual flaps. It is additionally possible to install humidity and temperature sensors in the system and equip all valves with actuator drives. They operate using spur gear rods, hoists, hydraulic cylinders or electric motors. They are also optionally available with a convenient control system. The AGRIMAT Siemens S7 handles all switching operations and a monitor displays the current status of the system. This is especially useful when there are several drying boxes. It ensures the operator keeps track of everything. Even remote data transmission via modem is possible.

Fan
In order to introduce appropriate pressure, a radial fan is mandatory. The pressure should be approximately 1,200 Pa (12 mbar) at a sufficient flow rate. If the fan applies high pressure at reduced airflow, the air can flow easily through wilted grass. The target air velocity through the hay box is 0.11 m/s. This guarantees high effectiveness. Air velocities that are too high promote fire effects and consequently air leaks, especially for low feed-in volumes. If a fan is equipped with a frequency control, the system can be optimally regulated.

Parameters for the design of a hay drying system:
- How many hectares (ha) of meadow are available?
- How many mowing cuts are possible? For example, in the Lake Constance region, up to 7 cuts are harvested; however in the South Tyrolean region at altitudes of 1,500 m above sea level, only 2 or at most 3 cuts per year are possible.
- How much manpower and what collecting machinery (loaders) are available?
- How many large cattle units must be supplied?
- Do specific biological criteria need to be observed?
- What is the altitude and what are the climate conditions at the location?
- Is the milk used for cheese production?
- Do specific biological criteria need to be observed?
- How many large cattle units must be supplied?
- How much manpower and what collecting machinery (loaders) are available?
- What is the altitude and what are the climate conditions at the location?
- Is the milk used for cheese production?

The height of the heap and the moisture content of the hay influence the required fan pressure.

Fan characteristic curve

Fan Characteristic Curve for Hay Box (Loose Storage)

Example of system characteristic curve for hay box (loose storage)

Dry matter content [%] of alfalfa hay

Note: Never apply humid air to dry hay!

Water activity (aw) is a measure of freely available water in the hay (or any other product). The aw value is important for determining the shelf life of foodstuffs because microorganisms need freely available water for their metabolic processes. A lack of freely available water slows the growth of microorganisms. The aw value is the ratio between the water vapour pressure of a substance and the saturation vapour pressure of pure water at the same temperature. Pure water has an aw value of 1. A completely dry substance has an aw value of 0. No bacteria or mould forms at an aw value below 0.6. As the aw value increases, the reaction speed of vitamins also increases, which causes the breakdown of the vitamins. This is another reason why it is important to keep the aw value low. Therefore, the relative humidity of the air introduced to hay with a DM content of 85% and a temperature of 20 °C must be under 50%. If the temperature of the hay is only around 10 °C, the relative humidity of the air introduced must not be higher than 43%.

Caution when aerating with outer air without dehumidification

Drying is only possible when the partial pressure of the hay is higher than the partial pressure of the air. Dehumidifying and/or heating increase the vapour pressure of the air and therefore the drying power. A sorption isotherm expresses the equilibrium moisture content of a substrate (hay) at a specific temperature. At the equilibrium point, no water transfers from the hay into the air or vice versa (no water absorption / water release).

Caution: Humid air would re-moisten hay which would then inevitably lead to damage such as fungus and bacteria development.

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Solar under-roof preheating
In most buildings, it is possible to use the energy from the sun by means of suitable air channeling (under the roof). This is termed solar preheating or under-roof preheating. An energy yield of approx. 300 W per m² of roof area is possible, which makes the AGRIFRIGOR™ system even more effective. The air flow can be channelled in the direction of the ridge or the eaves, and even a cross-flow towards the centre is possible. Under-roof preheating is always useful and reduces energy costs.

Hay box
A hay box for drying should not be too large. It is better to use several small boxes than one large one. That enables flexible harvesting logistics. In the case of meadow grass, a floor area of at least 10 m² or a box volume of at least 30 m³ should be provided per hectare of cut grass. The depth of a freshly stored layer should not be more than 3 m.

Ideally, the farmer should use a hay crane to “shake up” the hay material several times. This largely prevents ‘cushion’ formation. It also improves the conditions for air flow.

The drying process
Hay dries in layers. The hay layer which has been dried to equalization condition moves through the hay stack in the flow direction like a piston. It is important not to stop the drying process too soon. The top layer must be dried through before the air flow is switched off. This ensures that any condensate in the top layer is removed. Hay is dried in three steps. First, at a constant drying rate and temperature, capillary and osmotic forces transfer the moisture to the surface, where the water evaporates. In the second step, the drying rate drops and the temperature increases, while the evaporation continues to heat up. From a temperature of 225 °C there is a risk of spontaneous combustion.

Hay dries in layers. The hay layer which has been dried to equalization condition moves through the hay stack in the flow direction like a piston. It is important not to stop the drying process too soon. The top layer must be dried through before the air flow is switched off. This ensures that any condensate in the top layer is removed. Hay is dried in three steps. First, at a constant drying rate and temperature, capillary and osmotic forces transfer the moisture to the surface, where the water evaporates. In the second step, the drying rate drops and the temperature increases, while the evaporation continues to heat up. From a temperature of 225 °C there is a risk of spontaneous combustion.

Heat generation inside the hay stack
If hay contains residual moisture, e.g. in the stalks, this inevitably generates heat inside the hay stack. If the temperature rises to above 35 °C, this significantly impairs the constituents. Mould and bacteria contribute to breakdown of the fodder. The leaves and stalks take on a silvery or white discolouration. If the hay turns brown, this is the result of caramelisation of the sugar. Cows often like to eat this kind of hay, but it leads to a low milk yield.

Air distribution
Good air distribution is crucial in machine hay drying. Factors that must be considered here are technical air flow details and the building circumstances. It is also important that sufficient exhaust air openings are available for releasing the humid exhaust air. This is also significant for protection of the building material, especially because most hay storage buildings are made of wood. Preventing condensation in the building’s structural material is essential! The air intake channel must be large enough to prevent too much pressure from being released before the air enters the hay. The frame or grid underneath the hay should be laid transversely to the air flow to improve the air distribution.
It should also be noted that leaf-rich meadow hay is subject to higher pressure losses (13). Furthermore, regional differences must be taken into account. Hay and second or third cuts from the Algiū region have different values than those from North Germany or South Tyrol.

Consumption and maintenance costs

A cost-benefit analysis must take into account not only the investment costs, but also consumption and maintenance costs.

If the hay is pre-wilted in the sun, the fan will be in operation for 2.5 to 3 days per batch. Depending on the relative humidity of the outer air, the dehumidifier (heat pump) will be in operation for 1 to 2 days per batch.

Due to an additional internal heat exchanger, the AGRIFRIGOR™ dehumidifier has a relatively low electricity consumption. Annual maintenance of the dehumidifier requires approximately 1% – 1.5% of the procurement costs.

Round bale drying / bale drying

It is more difficult to dry bales than loose hay. Pre-wilting on the field should produce a DM content of 70%. The fans must apply a higher pressure than is necessary for loose hay. This results in higher energy consumption. The main problem is presented by uneven counterpressure conditions inside the bale (“cushions”). Overall, the good hay qualities that can be achieved from loose drying are not possible from round bale drying. Furthermore, additional machine and transport components are necessary.

System design – a matter for experts

When designing a hay drying system, a large number of parameters must be considered individually. Key factors are: the grassland area (size and quality), grass stocks, climate (altitude, weather data etc.), buildings available, farm logistics, electricity connection, available energy e.g. from a biogas plant and available manpower. This data can then be used to design a suitable system assembled from the modular AGRIFRIGOR™ range (dehumidifier, fan, hay box, under-roof preheating, control unit, after-heating). Only when all components mesh perfectly will the farmer get the results he wants.

Rules for eco-friendly hay aeration (modified according to 12)

• Aerated area (hay box area) approx. 25 to 30 m² / ha at layer depth of < 1.5 m
• Fill aeration box loosely and evenly
• Switch fan on while filling and operate constantly for the first 24 hours, especially if the hay temperature is over 35 °C
• Switch dehumidifier off if relative humidity of the intake air is below 50%.
• Design system for a drying time of 40 to 75 hours
• The average air velocity per m² of hay box floor area should be 0.11 m/s
• Design fan for 100 to 240 Pa per m³ of hay stack height
• Do not stack hay higher than 6 m
• Provide large exhaust air openings
• Dry to a dry matter content of 87%
• Pre-dry to a dry matter content of under 70% to prevent crumbling losses

The advantages of good hay (3):

• Higher fodder consumption (because lactic acid reduces appetite)
• Greater protein stability (more rumen-stable protein)
• Lower protein breakdown into NPN or ammonia
• More energy is stored (is retained)
• No silo smell (neighbours / tourism)
• Lower fodder contamination
• Hardly any clostridia (better for cheese making)
• No after-heating
• Lower weight during fodder handling
• Hay has a positive image
• High milk and meat quality due to healthy fodder

The extensive advantages of the AGRIFRIGOR™ process

• Eco-friendly
• Safe, homogeneous hay drying
• Weather-independent
• Easy to install in existing buildings / barns
• Crumbling losses largely eliminated
• Significantly reduced risk of fire
• Effective prevention of mould
• Easy operation
• Cost-effective

Summary

The AGRIFRIGOR™ process offers numerous benefits that make hay drying safer and more cost-effective while delivering high-quality hay.

28 Pressure loss of meadow hay with high leaf content (13)

29 Specific energy consumption of various hay drying methods (17)
AGRIFRIGOR™ range:
Hay drying heat pump (dehumidifier) and fans

AGRIFRIGOR™ and fans

FrigorTec – the specialist for cooling units and heat pumps:

Grain cooling GRANIFRIGOR™
Crane air conditioning CRANEFRIGOR™
Standard cooling STANDARDFRIGOR
Special solutions SHELTERFRIGOR
Insect heat treatment DEBUGGER
Hay dryer AGRIFRIGOR™

SERVICE – Our service keeps the units maintained and ensures the spare parts supply - worldwide.

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