



High quality cost-effective feed

Crimping is a cost-effective way to produce high-quality feed for all livestock. It improves profitability of the farm by reducing costs of investments (dryer, storage) and energy (oil, electricity). Production costs of crimped grain are much lower than those of dried grain.

Crimped grain is ready to feed without any further processing. It can be used directly from the storage for feeding as such or as a component of Total Mixed Rations (TMR) for cattle or in liquid feed for pigs.

Ensiling of crimped grain is based on lactic acid fermentation by lactic acid bacteria. Favourable environment for lactic acid fermentation is created by lowering the pH of crimped grain to the level of 4 and by anaerobic conditions.

Storage alternatives for feed grain

- **Drying:** Grain is dried below 15% moisture. Traditional and secure method for long term storage. Drawbacks include high costs and high dustiness of rolled dry grain.
- **Crimping:** Grain is harvested before full maturity at moisture content above 25%, crimped and ensiled in anaerobic conditions using Kemira KemiSile and Kemira AIV® products.
- **Moist whole grain preservation:** Grain is harvested at moisture content of 15% to 25% and preserved with Kemira Propcorn products to prevent spoilage caused by moulds and yeasts. Grain is stored under aerobic conditions.
- **Whole crop silage:** Whole plant is harvested and ensiled using Kemira KemiSile and Kemira AIV products.



Cultivation technique and harvesting

Grain for crimping can be cultivated similarly to grain for drying, but it is harvested 2–3 weeks earlier at the yellowish stage when the grain's energy content and protein content are at their highest. Early harvesting allows cultivation of late varieties with higher yield potential. Fertilization is also more flexible and manure can be used more freely.

Grain at the yellowish stage is softer and bigger than at the mature stage. The moisture content of the grain is typically 30–40%. Thus combine harvester should be set correctly to harvest the high moisture crop. Concave should be adjusted to tightest possible setting and drum speed should be set to maximum revolutions. Sieves should be fully open and fan should be half open. Reducing speed at harvesting and increasing cutting height reduces risk for blockages.

Crimping in a nut shell

- Harvest 2 to 3 weeks earlier than normally at yellowish stage; optimal grain moisture 30–40%
- Crimp on the field or at the storage with Murska crimper; crimp every grain
- Use Kemira AIV or Kemira KemiSile additive 3–5 liters per ton
- Store in bunker silos, plastic clamps, bags or tower silos
- Remember careful consolidation, covering and weighing
- Feeding can start about 3 weeks after closing the silo





Crimping and ensiling

A specialized Murska crimping machine is used to process the grain. Add the crimping additive into the crimping machine to achieve good mixing of additive in the grain. Rollers must be correctly set to crush every grain.

Crimped grain with high moisture content is easy to consolidate to exclude air. This secures good ensiling. If the grain is too dry (moisture below 30%), water could be added during crimping. However, it is always better to harvest at the correct moisture content than to add water afterwards. Due to the high

moisture content of the grain, the crimping and ensiling should happen within 24 hours from harvesting, otherwise the grain may heat up. Heating is especially a problem, if no crimping additive or only biological additive is used.

If the grain is crimped in the field, it is unloaded directly from the combine into the crimper, crimped, and at the same time the additive is added. Finally, crimped grain is lifted with elevator to the trailer and transported to the storage site.

Kemira AIV and KemiSile application

Kemira AIV and KemiSile additives are recommended for crimping. The additives reduce pH of the crimped grain and prevent also directly growth of undesirable microbes. Surface of the crimped grain can be treated with undiluted additive to prevent spoilage of the top layer. Kemira AIV and KemiSile additives ensure high nutritive value of crimped grain until feeding.

Kemira AIV and KemiSile additives are dosed according to the moisture content of the crimped grain

Moisture	Application rates
35-45%	3 liters/ton
30-35%	4 liters/ton
25-30%	5 liters/ton

For protein crops, such as peas and beans, increase the dosage by 1 liter per ton. The additive is applied by a pump applicator.

Storage

Crimped grain can be stored in plastic tubes, bunker/horizontal silos, clamps or airtight tower silos. Consolidation in a bunker silo or a plastic clamp can be done using a tractor with a front loader or corresponding machinery. If crimping is done at the silo, elevator is used to transport grain from the trailer into the crimper. Grain can also be loaded into the crimper from a clean concrete with a farm loader. Capacity of the crimper is defined by the amount of grain to be crimped and by the capacity of the combine so that combining can be done continuously without breaks. The biggest Murska crimpers have a capacity of approximately 30 tons per hour, which enables use of high capacity combines. The most effective crimpers are powered by tractors: one tractor is running the crimper and the other is filling the clamp. Crimped grain can also be bagged. The simplest storage is a plastic clamp at the corner of a field.

Independent of the way of storage, the most important issues are careful crimping, even application of the additive, careful consolidation, proper sealing and finally putting weights on the top of the clamp. Feeds like brewers' grain, bran or other co-products or dried rolled grain can be used as the top weight. They can be fed together with the crimped grain and they build also an effective barrier against rats and mice.

The clamp should be kept closed two to three weeks before opening in order to allow enough time for fermentation, which reduces the risk for warming up of the feed. Clamp size should match with the feeding rate so that material is removed from the whole face as often as possible, i.e. at least once a week, or more frequently in very warm weather. It is recommended to cut feed from the face rather than dig it out in order to minimize air penetration into the feed. Air penetration may result in heating and growth of fungi, such as moulds and yeasts, at the face.

Bagging of crimped grain

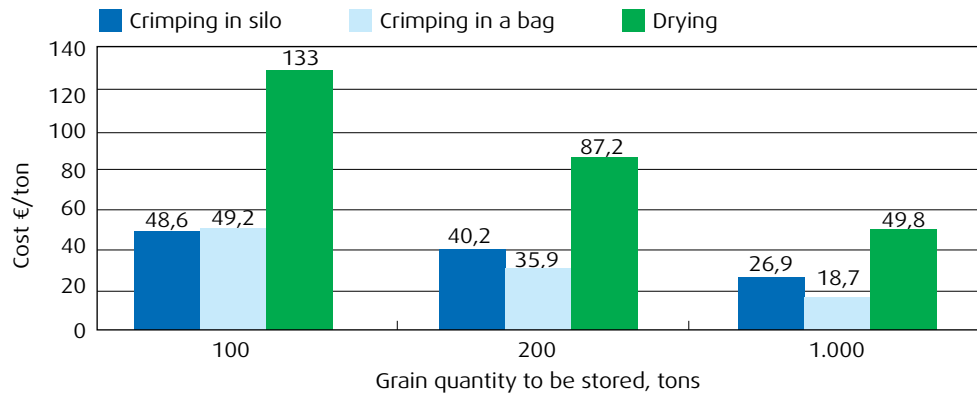
Bagging of crimped grain in plastic tubes is low-cost and simple grain processing and storage method. Grain is combined, transported to the crimping place, crimped and bagged in one working phase. Grain is moved from the trailer with front loader elevator directly to the rollers and into the packing tunnel. Bagging is easy, since no consolidation or weighing is needed. No fixed storages are needed and size of the tube can be adjusted according to the yield. Crimping in bags is flexible as it can be stopped at any time and continued later. Bagging is also less weather dependent than ensiling in clamp silos.



Crimping is cost effective

The costs of crimping and drying of grain were compared by TTS Institute in Finland. The calculations clearly indicated that crimping significantly reduced the preservation costs: When the total quantity of 200 tons was crimped instead of drying, the variable costs and total costs were reduced by 58% and 54%, respectively resulting in total savings of ca.10 000 Euros. The higher the crimped quantities were, the more was saved: when preserving 1000 tons, the cost benefit was over 30 000 Euros. Further savings were gained when the crimped grain was stored in plastic tubes instead of silos. However, exact calculations on the farm level require specific data of the farm.

Effect of preservation method and quantity on the costs (Source: TTS/2008)



Besides the economical benefits, crimped grain has many other advantages over dried grain. These include good palatability, dust free grain, less weather dependent harvesting and high nutritive value.

Valuable and low-cost feed for all livestock

Despite of the earlier harvesting time, the nutrient content of crimped grain is similar to that of the grain harvested at full mature stage. Fermentation process during ensiling causes some changes in the composition and nutrient content of the grain. Sugar content decreases as the sugars are fermented into lactic acid. The contents of starch, NDF fiber, phytate phosphorus, vitamin E and β -glucan decrease as well.

Ruminants

Beef cattle grow as well or even faster with crimped grain as compared to dried grain. Several studies have confirmed that dairy cows produce as much milk with crimped grain as with dried grain. Overall nutritive value of crimped grain for ruminants is similar to that of dried grain.

Several studies indicate that replacing dried grain by ensiled high-moisture grain in the diet of dairy cows does not affect the milk yield and composition. In a recent Finnish study the cows were fed by TMR containing grass silage 55%, barley 29%, rape seed 10%, molassed sugar beet feed 5% and minerals. Barley was either dry or crimped. The type of grain did not affect the milk yield. Independent of the diet, multiparous cows produced 30–34 liters milk daily and primiparous cows 25 liters. However, milk fat content tended to be higher in cows fed with crimped grain. This is in line with the rumen fermentation studies with crimped grain showing higher acetic and butyric acid contents in the rumen fluid from dairy cows.



The actual amounts of crimped grain fed or used in TMR are higher than those of dried grain due to lower dry matter content of crimped grain. Otherwise crimped grain can be fed as dry grain and it can completely replace dry grain in feeding. Moisture content of crimped grain can somewhat vary, thus dry matter content should be determined every one to two weeks in order to know the amount of dry matter fed to the animals. Dry matter content can be analysed using microwave oven and letter-balance.

Pigs

Crimped grain can be fed to pigs as such. It fits perfectly for liquid feeding. In practice, 8-10% variation in dry matter content of grain does not affect the daily growth or the feed conversion ratio. Vitamin E content is lower in crimped grain than in dried grain, which should be taken into account in feeding.

Nutrient digestibility of diets based on crimped or dried barley in growing pigs (Valaja et al., 2000)

Digestibility, %	Dried barley	Crimped barley
Organic matter	85	88
Crude protein	81	87
Phosphorus	39	53

Due to greater digestibility, energy value of crimped barley is 5% higher than that of dried barley. Digestibility of crimped grain is greater due to earlier harvesting and decreased β -glucan content. β -glucan is known to increase the

viscosity of gut content in pigs and poultry leading to reduced digestibility of nutrients. Lactic acid produced during ensiling, together with the acid additives, have positive influence on the digestion. In practice, crimped grain can fully replace dried grain in the feeding of pigs.

Feeding weaned piglets with crimped grain has improved the feed conversion ratio and decreased diarrhoea as compared to feeding with dried grain (Siljander-Rasi, 2001)

	Dried barley	Crimped barley
FCR* (kg DM/kg)	2.02	1.98
Diarrhoea index**	7.7	4.0

*FCR = Feed conversion ratio

**Diarrhoea index = the time for diarrhoea in days x severity of diarrhoea

Growing-finishing pigs grow better with crimped grain than with dried grain (Siljander-Rasi et al., 2000)

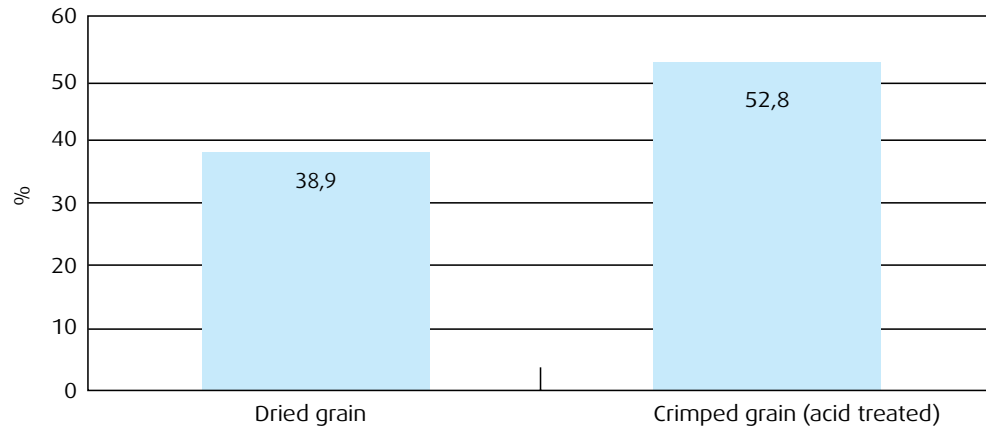
	Dried barley	Crimped barley
Time to slaughter (d)	87.6	84.6
Daily weight gain (g/d)	876	912
FCR* (kg DM/kg)	2.31	2.23

*FCR = Feed conversion ratio

Feeding crimped grain reduces phosphorus excretion into urine compared to feeding dried grain. Big part of the phosphorus in grains is poorly available to animals since it is bound to phytic acid. However, phytic acid is degraded during ensiling due to high moisture content, acid conditions and acid additives.

The amount of phosphorus bound to phytic acid in crimped grain is only 1/5 of that in dried grain. All this results to ca. 15% increase in phosphorus digestibility in diets containing crimped grains. It is estimated that feeding crimped grain decreases the excretion of phosphorus by 150–200 g per pig during the whole production cycle.

Digestibility of phosphorus in pigs (Valaja et al., 2000)



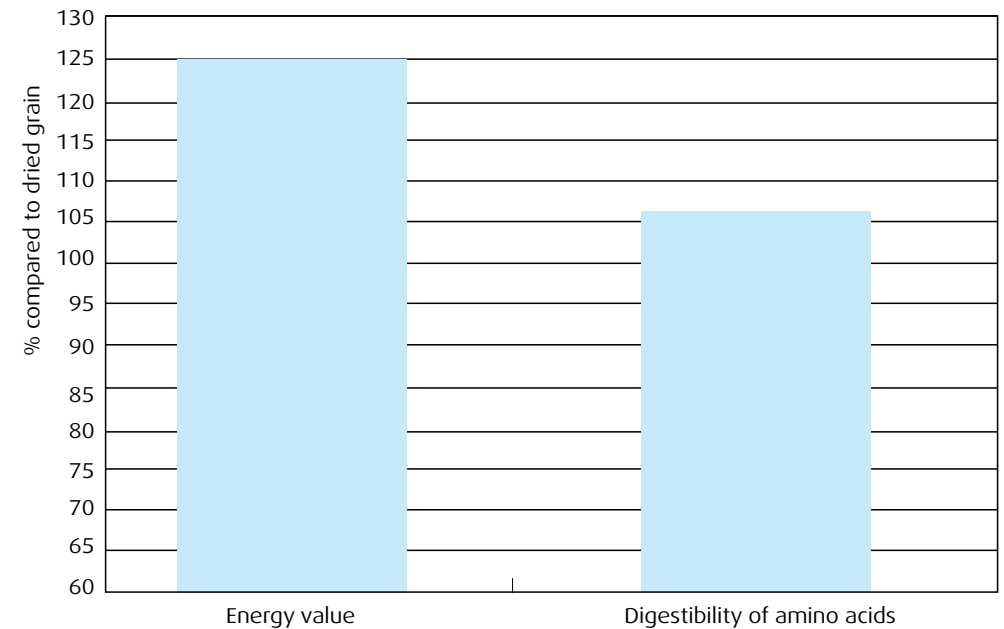


Poultry

Crimped grain as such is palatable feed for poultry, too. Crimped grain improves both daily weight gain and feed conversion ratio of broiler chickens. This is related to the 25% higher energy value of crimped grain as compared to that of dried grain. Energy value is increased due to the lower β -glucan content in crimped grain resulting in lower gut content viscosity. This effect is similar to that of β -glucanase enzyme. Digestibility of lysine and threonine are increased in broilers fed crimped grain as compared to those fed dried grain. Similarly to pigs, digestibility of phosphorus is increased, too.

Energy value and amino acid digestibility of crimped barley in broilers

(Siljander-Rasi et al. 2000, Perttilä et al. 2002)



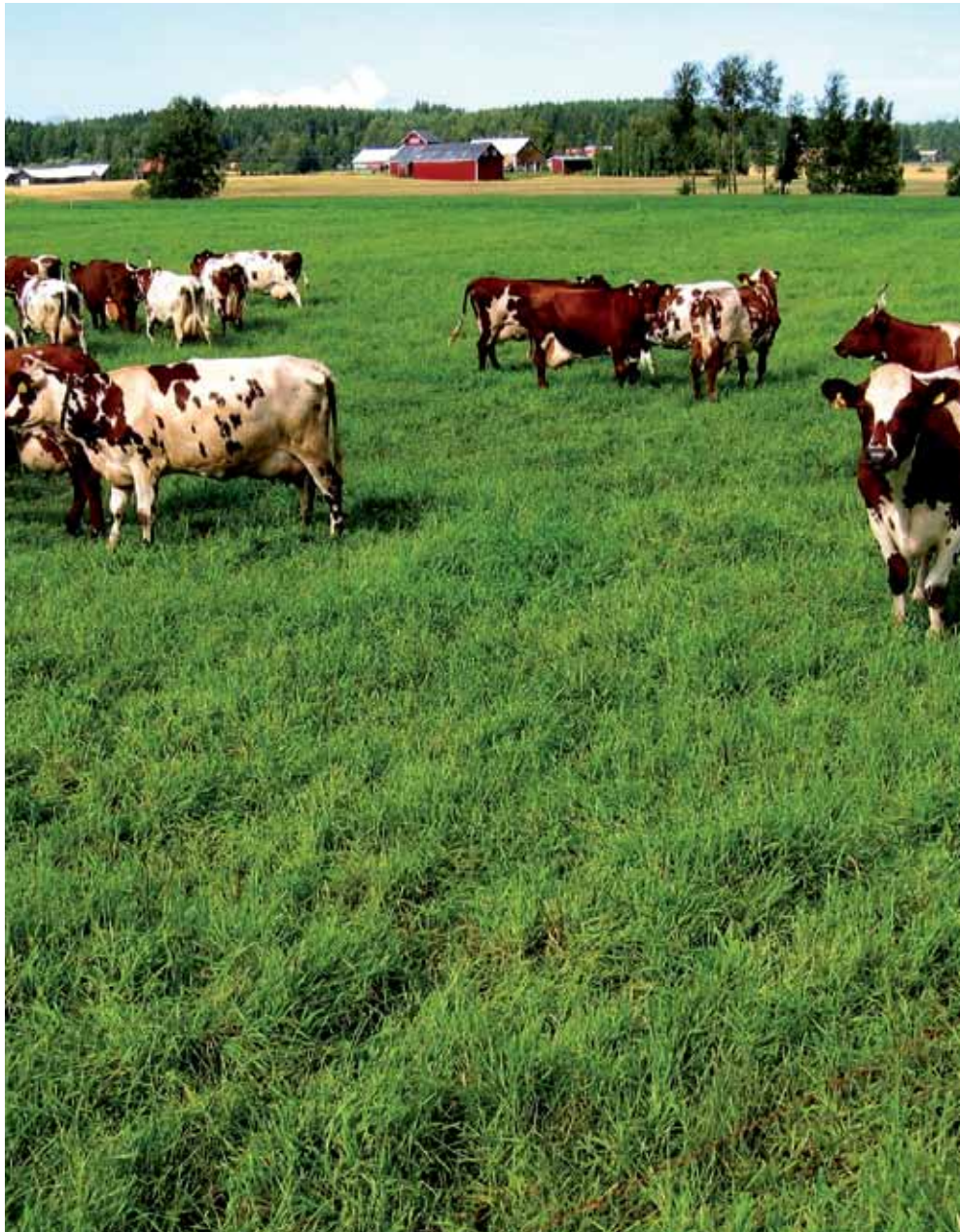
High-value low-cost feed with crimping

- Crimped grain has high nutritive value
- Crimped grain fits perfectly in total mixed rations
- Crimped grain can be used for all livestock
- Cost per energy unit of crimped grain is lower than that of dried grain
- Phosphorus utilization in pigs and poultry fed with crimped grain is better than in those fed with dried grain
- Crimped grain fits well in liquid feeding systems
- Crimped grain is dust free
- Crimping is a low-energy method of processing feed grain
- Crimping allows the use of later cereal and maize varieties; harvesting even under unfavourable weather conditions
- Drying capacity does not limit harvesting
- Crimping extends the operating time of combines in the autumn

Literature:

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