MAIZE GRAIN FOR DAIRY COWS
During the past decade New Zealand dairy farms have intensified with farmers milking more cows per hectare and producing more milk per cow. Feed demand per hectare has increased at a greater rate than pasture supply and as a consequence, there has been a move away from all-grass towards farm systems that strategically use supplementary feeds.

While many farmers have recognised the benefits of feeding home-grown or purchased forages such as maize silage, there has been a large increase in the use of concentrates fed mainly through in-shed feeding systems. In-shed feeding systems are convenient allowing farmers to easily feed concentrates during milking by simply pushing a button or pulling a cord. While feeding forages normally requires some forward planning, concentrates can usually be purchased as required. There are a range of concentrates available on the New Zealand market including grains, dairy meal, molasses and palm kernel extract. Maize grain is increasing in popularity with dairy farmers. It has a number of key advantages over other grains and concentrates.

### Key Advantages of Maize Grain Over Other Grains and Concentrates

- It is the highest quality commonly-used concentrate with higher energy levels than other grains, molasses, palm kernel extract and the majority of dairy meals.
- It is more slowly digested in the rumen than other grains, decreasing the risk of acidosis.
- It has a high starch content which drives milk protein percentage. Since milk protein is worth substantially more than milk fat, this increases milk solids returns.
- It’s low nitrogen content means it can be used to reduce urinary nitrogen levels, decreasing nitrogen leaching.
- Maize grain is locally grown which means its price and supply is not subject to the exchange rate or overseas demand.
High producing cows have a high energy requirement and they must be fed high amounts (kgDM) of high energy density feeds.

A concentrate is a feed with a high concentration of energy. It contains highly digestible components like starches, sugars, other readily available carbohydrates, and fats or oils. Concentrates are mostly processed, i.e. ground, kibbled or pelleted, and have very little physically effective fibre. Concentrates create less pasture substitution than forages (such as fresh crops, silages or hay) and they can add additional energy and other nutrients to fill deficits in the diet. Pasture quality varies throughout the season and pasture-based diets can be deficient in energy and/or protein at times of the year. The composition of the base diet (which in New Zealand is usually pasture) will determine the best concentrate option to feed.

Concentrates which are commonly available in New Zealand include dairy meals, maize or cereal grains (wheat and barley), molasses and palm kernel expeller (PKE). Maize grain has higher energy content than other grains and many other commonly available concentrates.

Concentrates have differing sources of energy. Some feeds deliver energy via sugar (e.g. molasses) or fibre and fat (e.g. PKE). Maize grain energy comes mainly from starch. The nutrient composition of feeds influences how they are digested and the end products of digestion affect milk component levels (Figure 2).

RATE OF STARCH DIGESTION AND OTHER NUTRITIONAL BENEFITS

Although starch and sugar deliver high density energy, over feeding can cause a negative animal health effect known as acidosis. Acidosis occurs when high levels of sugar or starch are converted to large quantities of acid by the rumen microbes. This results in a fast reduction in rumen pH with negative effects on rumen digestion. While the amount of starch or sugar fed is critical, the speed and extent of starch digestion also influence the risk of acidosis. Maize starch is less risky than many other starch types because it is digested more slowly and to a lesser extent in the rumen.
An extended research project in Germany demonstrated that maize starch is digested in the rumen to a lower extent than wheat starch. This resulted in a healthier rumen pH reflected also by a higher rumen digestion of fibre which is a typical indicator of rumen health.

### Table 1. Effects of different concentrates (containing 87% maize grain or 87% wheat) on rumen digestion

<table>
<thead>
<tr>
<th></th>
<th>MAIZE</th>
<th>WHEAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starch digested in rumen (%)</td>
<td>76&lt;sup&gt;a&lt;/sup&gt;</td>
<td>95&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Rumen pH</td>
<td>5.8&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.5&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Crude fibre digestion of diet in rumen</td>
<td>76&lt;sup&gt;a&lt;/sup&gt;</td>
<td>69&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>ab</sup> Values with different superscripts are significantly different (P<0.05).

### IMPACT OF MAIZE GRAIN ON MILK PROTEIN

Feeding starch, fibre or sugar based feeds has an effect not only on rumen digestion, but also on milk yield and milk composition.

A recent New Zealand study<sup>6</sup> investigated the effects of feeding different types of concentrates in addition to pasture:

- Starch - maize grain.
- Fibre - broll (wheat middlings).
- Sugar - molasses.

While energy intakes were similar between starch and fibre feeds, there were significant differences in milk yield and composition.

### Table 2. Effect of carbohydrate type on milk and milk component yields

<table>
<thead>
<tr>
<th></th>
<th>PASTURE</th>
<th>STARCH (MAIZE GRAIN)</th>
<th>FIBRE (BROLL)</th>
<th>SUGAR (MOLASSES)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drymatter intake, kg/day</td>
<td>14.9</td>
<td>17.6</td>
<td>18.1</td>
<td>16.1</td>
</tr>
<tr>
<td>Pasture, kgDM/day</td>
<td>14.9</td>
<td>13.7</td>
<td>13.5</td>
<td>14.9</td>
</tr>
<tr>
<td>Concentrate kgDM/day</td>
<td>0</td>
<td>3.9</td>
<td>4.7</td>
<td>1.2</td>
</tr>
<tr>
<td>ME intake MJ/day</td>
<td>2119</td>
<td>2369</td>
<td>2516</td>
<td>2214</td>
</tr>
<tr>
<td>Milk yield kg/day</td>
<td>23.14</td>
<td>27.7</td>
<td>26.21</td>
<td>23.56</td>
</tr>
<tr>
<td>Fat yield kg/day</td>
<td>1.03</td>
<td>1.07</td>
<td>1.16</td>
<td>1.06</td>
</tr>
<tr>
<td>Crude protein yield kg/DM</td>
<td>0.8</td>
<td>1.01</td>
<td>0.94</td>
<td>0.79</td>
</tr>
</tbody>
</table>

Maize grain feeding resulted in higher milk and milk protein yield. The authors concluded: “Early lactation cows offered energetically similar supplements differing in carbohydrate type responded differently in milk and milk component yields. Compared with an un-supplemented pasture diet, starch-based supplements increased milk and milk protein yield, but did not affect fat yield, whereas fibre based supplements primarily increased milk and milk fat yield. Bolus doses of sugar (molasses) did not affect milk or milk component yields in this study<sup>5</sup>.”

### Figure 4. Impact of feeding different supplement energy types on milk yield and composition<sup>6</sup>

**Impact of Feeding Maize Grain on Cow Condition Score and Reproductive Performance**

The benefits of having cows in better condition (the target is condition score 5.0 for mature cows and 5.5 for two and three year old cows) are substantial. A cow calving at condition score 5.0 will produce on average 12 kg more milksolids than a cow that calves at condition score 4.0. Cows that are fatter at calving cycle earlier, have higher in-calf rates and are more likely to give birth to a heifer calf the following year.

### Figure 5. Relationship between BCS at calving and annual milksolids production<sup>7</sup>
Following the post-calving period of body condition score (BCS) loss, cows begin to gain BCS. The rate of gain is affected by both genetics and nutrition. In general high milk production cows gain less BCS than low yielding cows while milking cows fed supplement that contains non-structural carbohydrates (i.e. starch and sugar) gain more BCS than cows fed pasture alone. With the decline in mid-season pasture quality (and possibly insufficient quantity), BCS gain slows down or cows lose BCS once more. This loss of BCS is different to the loss in BCS post-calving and can be minimised by providing pasture quality is high or by providing the cow with high quality supplementary feeds when there is insufficient pasture\(^7\).

Cows selected for high milk production preferentially partition nutrients to milk production and not to BCS gain. BCS increases much more quickly when cows are offered supplements to pasture after they have been dried off. However different feeds are used with different efficiencies for BCS gain. Energy in autumn pasture is used inefficiently for gaining BCS. Energy from feeds like pasture silage, palm kernel extract (PKE) and maize silage are used 50% more efficiently\(^7\).

**SUBSTITUTION RATES (CONCENTRATE VS. FORAGE)**

When grazing cows are fed supplements, pasture drymatter intake usually decreases. The rate at which pasture is replaced by supplements is known as the substitution rate.

Forage supplementation decreases pasture drymatter intake more than concentrate. Trials have shown that the substitution rate ranged from 0.84 to 1.02 kg/kg for grass silage supplementation and from 0.11 to 0.50 kg/kg for concentrate supplementation\(^8\).

In practical terms this means that feeding concentrates to grazing cows will reduce pasture intake, on average 0.3 kg DM pasture/day for each kgDM concentrate eaten. It will lift total energy intake and enable cows to produce more because metabolisable energy intake is the first limiting factor for milk production for most New Zealand cows.

Feeding forage (e.g. pasture, cereal or maize silage) results in higher pasture substitution rates than feeding concentrates. This reduces grazing pressure and can be used to manipulate farm pasture cover levels, reducing overgrazing.

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### REDUCED DIETARY NITROGEN

Throughout the majority of the year New Zealand’s ryegrass-clover pasture contains more than 20% crude protein. At times, especially in the spring and during the autumn flush, pasture protein level can exceed 30% crude protein. Lactating cows require 14-18 % crude protein to support milk production. While nitrogen excretion in milk and dung increases linearly with dietary nitrogen intake, nitrogen concentration in the urine increases exponentially as nitrogen intake increases\(^9\)\(^\text{10}\). Put simply, the more nitrogen cows eat above requirements, the more they excrete in the urine and urinary nitrogen levels may be as high as 1000 kg N per ha.

Environment Waikato data shows that for a farm producing 850 kgMS/ha, using 100 kg fertiliser N with effluent applied to the land, 69% of the nitrogen loss comes from urinary nitrogen. Feeding a low protein feedstuff such as maize silage (7.5% crude protein) or maize grain (8% crude protein) in conjunction with high protein pasture dilutes dietary protein content and reduces nitrogen excretion by the cow (Table 3). Maize grain can be grown in lower risk areas and fed in sensitive catchments to decrease dietary and therefore urinary nitrogen.

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![Table 3. Effect of feed source on N output in milk, dung and urine in absolute and relative terms (in parenthesis)\(^{11}\)](image)

<table>
<thead>
<tr>
<th>TYPE OF SILAGE</th>
<th>N INTAKE* (kgN/cow)</th>
<th>N OUTPUTkgN/COW (% INTAKE)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Milk</td>
<td>Dung</td>
</tr>
<tr>
<td>Lucerne</td>
<td>37</td>
<td>6 (16)</td>
</tr>
<tr>
<td>Pasture</td>
<td>24</td>
<td>6 (25)</td>
</tr>
<tr>
<td>Cereal</td>
<td>16</td>
<td>6 (38)</td>
</tr>
<tr>
<td>Maize</td>
<td>12</td>
<td>6 (50)</td>
</tr>
</tbody>
</table>

---

![Figure 6. The relationship between daily total N intake and N output in dung, milk and urine\(^{10}\)](image)
The response rate to supplements varies depending on a number of factors including the type of supplement, the time of the year when it is fed, pasture cover levels and the total dry matter intake.

Strategic feeding (e.g. using feeds to extend lactation or to fill feed deficits during the lactation) will normally generate a higher milk solids response rate than feeding continuously throughout the lactation. DairyNZ’s Facts and Figures for New Zealand Dairy Farmers gives a range of possible response rates to good quality supplements (>10.5 ME) fed with low (<15%) wastage (Table 4).

Data collected from 60 seasonal supply farms situated in the lower North Island and South Island was used to determine the response to grain being achieved under commercial conditions. On average the farms fed 179 kg grain per cow per year with the range between 0-952 kg per cow per lactation. Average milk solids production was 435 kg MS/cow with a range from 310-595 kg MS/cow. The average response to grain was 88 g MS/kg DM fed in the 2009-10 season and 146 g MS/kg DM fed in the 2010-11 season. The average response over the two years was 117 g MS/kg DM grain. The short-term response to grain varied between seasons with the response rates being:

- Spring (50 - 54 g/kg DM grain fed).
- Summer (141 - 193 g/kg DM grain fed).
- Autumn (116 - 138 g/kg DM grain fed).

Information published by DairyNZ shows that milk production is determined by the amount of energy a cow eats but the composition of the milk solids she produces is affected by the type of supplement fed.

When cows are fed a starch or sugar-based supplement, they produce more milk protein.

When cows are fed a fibre based supplement, they produce more milk fat.

Since milk protein is worth two to three times more than milk fat, starch and sugar based supplements will deliver more milk revenue than fibre-based supplements.

Table 4: Seasonal milk solids response to supplements (on a dry matter and energy (MJ ME) basis)

<table>
<thead>
<tr>
<th>TIME OF SEASON</th>
<th>MILK RESPONSE RATE*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(gMS/HMJME)</td>
</tr>
<tr>
<td>Spring</td>
<td>8.0-12.0</td>
</tr>
<tr>
<td>Summer</td>
<td>7.5-11.0</td>
</tr>
<tr>
<td>Autumn</td>
<td>7.0-8.0</td>
</tr>
</tbody>
</table>

* Residuals < 6 clicks (1,350 kg DM/ha) if no supplement fed.

In a number of New Zealand trials have measured the milk solids response of cows fed grain:

- In the 1.75 t MS/ha trial, Herd 6 was fed a total of 1,247 kg maize grain per cow during the lactation. The milk solids response rate was 99 g MS/kg DM fed or 7.6 g MS/MJ ME.

- Penno et al. (1996) offered rolled maize to grazing dairy cows in a two year farm-let experiment. At a stocking rate of 3.24 Friesian cows per hectare annual milk yields were increased by 76 g MS/kg DM of grain fed. When stocking rates were increased to 4.48 cows per hectare annual response rate was increased to 88 g MS/kg DM grain fed.

- In a further farmlet trial Friesian cows stocked at 4.41 cows per ha conducted over three complete seasons the milk solids response was 96 g MS/kg DM grain. Penno concluded that full lactation responses of 7.5 g MS/MJ ME can be expected when grain is offered to dairy cows grazing restricted amounts of pasture.

Information published by DairyNZ shows that milk production is determined by the amount of energy a cow eats but the composition of the milk solids she produces is affected by the type of supplement fed.

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- When cows are fed a fibre based supplement, they produce more milk fat.

Since milk protein is worth two to three times more than milk fat, starch and sugar based supplements will deliver more milk revenue than fibre-based supplements.

Table 5: Estimated milk revenue ($ in bold) from feeding 1 t DM of different supplements fed through an in-shed feeding system

<table>
<thead>
<tr>
<th>FEED</th>
<th>PERCENT OF EXTRA MILKSOLIDS IS:</th>
<th>MILK PRICE ($/kg MS)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fat</td>
<td>Protein</td>
</tr>
<tr>
<td>PKE</td>
<td>75</td>
<td>25</td>
</tr>
<tr>
<td>barley</td>
<td>75</td>
<td>25</td>
</tr>
<tr>
<td>maize grain</td>
<td>80</td>
<td>20</td>
</tr>
</tbody>
</table>

*Adapted from Roche and Hedley, 2011. Supplements – the facts to help improve your bottom line. DairyNZ Technical Series July, 2011 p 6-10. Assumes grazing residuals of 1,500-1,600 kg DM (7-8 clicks on RPM). Responses decline when residuals are higher than 1,600 kg DM (i.e. cows are better fed). For a full list of assumptions see http://www.dairynz.co.nz/file/fileid/37671.
OTHER BENEFITS OF FEEDING MAIZE GRAIN

LABOUR
There is minimal labour required to feed maize grain through an in-shed feeding system compared to feeding silage or hay or grazing a green-feed crop. Usually the person milking the herd can “push a button” or “pull a cord” to feed each row of cows.

CONVENIENCE
Maize grain is convenient to feed in that it can be ordered when required and delivered within a few days. In many cases payment for the grain is due at the end of the month by which time the grain has been fed and a milk return generated. This is very good for cashflow.

RELIABILITY OF SUPPLY
There is an established maize grain industry in New Zealand ensuring year-round supply of maize grain as and when required.

PRICE STABILITY
There are a large number of factors that impact the NZ landed price of imported feeds such as palm kernel. These include:

- Production costs at origin.
- World demand for the product.
- Shipping costs.
- Exchange rate.

Locally grown maize grain prices are subjected to less variation with the pricing being determined only by growing costs and local demand relative to supply. While the price of imported feeds tends to change on a daily basis, maize grain price is more stable over time.

MAIZE GRAIN OPTIONS FOR DAIRY COWS

Maize grain can be fed as earlage, high moisture corn or dry grain. Product form has implications for pricing, logistics, losses and feed value.

<table>
<thead>
<tr>
<th>MAIZE PRODUCT</th>
<th>COMPOSITION</th>
<th>HARVEST AND PROCESSING METHOD</th>
<th>STORAGE METHOD</th>
<th>ME (MJ/kg DM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earlage</td>
<td>100% kernels + 100% spindle + 80-100% husks + &lt;20% stover</td>
<td>Precision chopper with ear picker</td>
<td>Silage (bunker, bag or bale)</td>
<td>12.5</td>
</tr>
<tr>
<td>High moisture corn</td>
<td>100% kernels</td>
<td>Combine and mill</td>
<td>Silage (bunker, bag or bale)</td>
<td>13.6</td>
</tr>
<tr>
<td>Dry grain</td>
<td>100% kernels</td>
<td>Combine, drying and cracking or grinding</td>
<td>Dry grain in bins</td>
<td>13.6</td>
</tr>
</tbody>
</table>

Table 7. Nutritional value of maize product options

<table>
<thead>
<tr>
<th>MAIZE PRODUCT</th>
<th>DRYMATTER %</th>
<th>STARCH %DM</th>
<th>NDF %DM</th>
<th>CRUDE PROTEIN %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earlage</td>
<td>55-65</td>
<td>50-60</td>
<td>20-25</td>
<td>8-10</td>
</tr>
<tr>
<td>High moisture corn</td>
<td>68-72</td>
<td>69-72</td>
<td>8-10</td>
<td>10</td>
</tr>
<tr>
<td>Dry grain</td>
<td>89</td>
<td>75</td>
<td>9</td>
<td>8</td>
</tr>
</tbody>
</table>
**DRY MAIZE GRAIN**

Maize grain is normally harvested at 23-26% moisture (74-76% DM), transported to a drier and air dried to 14% moisture (86% DM). Dry grain has advantages for transport because very little water has to be shipped. It is also very stable and will hold its quality for long periods as long as it is kept dry. Dry grain needs to be processed to allow cows to efficiently utilise the nutrients it contains (see pages 15-17 for more details).

The feed value of dry grain is characterised by high energy density and a lower rumen degradation rate when compared to high moisture corn (HMC) or maize earlage.

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**ALKAGRAIN MAIZE**

Alkagrain maize is a mix of maize grain and patented pellets which contain a unique mix of urea, soya and a specialist enzyme that breaks down urea to give off ammonia which is a powerful preservative. Maize grain is harvested at 65-82% moisture, processed, mixed with the pellets and stored in an airtight AgBag. Alkagrain maize has a higher protein content and higher digestibility than dry maize grain.

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**HIGH MOISTURE CORN**

High moisture corn is typically harvested when the maize grain is between 68-72% dry matter using a combine. The grain is rolled prior to fermentation. The key advantages of high moisture corn are that it can be harvested prior to normal grain harvest maturity, there is no drying cost and it is very high in feed value. Dr. Mike Hutjens (University of Illinois, USA) likens this product to “rocket fuel”.

High moisture corn is not as easy to transport as dry grain. It must be ensiled and there is a loss in dry matter during the ensiling to feed-out process. High moisture corn has a potential for aerobic instability (heating at feed-out time) and because it has a relatively high moisture content for a concentrate, it will not flow through most in-shed feeding systems.

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**EARLAGE**

Maize earlage is an ensiled product that has a feed value and yield that falls between that of maize grain and maize silage. It is normally harvested at 55-65% dry matter using a snapper head on a forage harvester.

Earlage is normally harvested several weeks prior to grain harvest and because it is an ensiled product there is no requirement for drying. Earlage delivers some physically effective fibre which makes it safer to feed than other concentrate options.

Earlage must be ensiled and there is a loss in dry matter during the ensiling to feed-out process. It contains more water and is less energy dense than dry grain so the transport cost per unit of energy is higher. Earlage has a potential for aerobic instability (heating at feed-out time) and it will not flow through in-shed feeding systems.

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**FEEDING GUIDELINES FOR MAIZE GRAIN**

**FEEDING RATES**

Maize grain feeding rates will vary depending on the age and production level of livestock and the amount and type of other feeds in the diet. General recommendations are as follows:

- Feed a maximum of 30% of the total dry matter intake as maize grain*.
- Start at lower rates (e.g. 1 kg maize grain per cow per day) and increase the feeding rates gradually over 7-10 days.
- Feed a maximum of 2.5 kg DM maize grain in a single feed.

* Feeding rates will be lower in diets that contain other sources of carbohydrates (e.g. other grains, dairy meal, molasses or high sugar or starch byproducts). Talk to your local veterinarian or nutritionist for farm specific advice.

**ACIDOSIS**

Acidosis can occur when cows are fed either too much starch or sugar, or where the starchy/sugary feed has been introduced too rapidly into the cow’s diet. Starch and sugars are digested quickly by microorganisms in the rumen of the cow. The end products of this digestion are acids, which the cow then uses for energy. However, when a cow eats a lot of starchy or sugary feeds and/or she is not accustomed to these feeds, she produces dangerous levels of lactic acid, becomes ill, and in severe cases can die.

To reduce the risk of rumen acidosis always:

- Introduce high starch or sugar feeds into the diet slowly.
- Watch total dietary levels of starchy or sugar feeds.
- Ensure that the diet contains adequate levels of long (functional) fibre.
- Ensure that individual animals cannot gorge high risk feeds.
When unprocessed maize grain is fed to dairy cows 15-30% will pass through the digestive tract as undigested whole grain therefore it must be processed to maximise its feed value. Processing grain disrupts the kernel and exposes the nutrients to rumen fermentation and lower gut digestion. Reducing the particle size or increasing starch solubility (such as in gelatinised or high moisture grain) increases the rate and level of rumen fermentation and digestion.

**METHODS OF PROCESSING MAIZE GRAIN FOR DAIRY COWS**

There are a number of different mechanical methods that can be used to reduce the particle size of maize grain. In New Zealand the most common are the hammer mill and roller mill although other options include disk mills, steam-flaking and steam-rolling.

**HAMMER MILL ADVANTAGES AND DISADVANTAGES**

**Advantages**
- Produce a wide range of particle sizes.
- Work with any friable material and fibre.
- Less initial purchase cost compared to roller mills.
- Offer minimal expense for maintenance.
- Generally feature uncomplicated operation.

**Disadvantages**
- Provide less efficient use of energy compared to the roller mill.
- May generate heat (source of energy loss).
- May create dust and noise pollution.
- Produce greater particle size variability (less uniform).

**ROLLER MILL ADVANTAGES AND DISADVANTAGES**

**Advantages**
- Energy efficient.
- Uniform particle-size distribution.
- Little noise and dust generation.

**Disadvantages**
- Little or no effect on fibre.
- Particles tend to be irregular in shape and dimension.
- May have high initial cost (depends on system design).
- When required, maintenance can be expensive.

One of the key benefits of roller mills is that they tend to produce very evenly sized particles with fewer fines (less dust) and large particles which may pass through the cow undigested. Disc mills are a compromise between roller mills and hammer mills. They produce more noise and fines than a roller mill but less noise and fines than a hammer mill.
STEAM FLAKING AND STEAM ROLLING

Steam-flaking and steam-rolling gelatinise starch by heat and steam application. However, the degree of “cook” is highly dependent on the amount of moisture, pressure, and heat actually obtained. Steam-rolled grain is usually steamed for 10-15 minutes to increase grain moisture. Then, it is rolled into a thick flake with a density around 47.5 kg/hL. Steam-flaked grain is steamed for 30-60 minutes in a vertical steam chamber to increase grain moisture to 18-20%. Then, it is flaked through rollers to a density of around 30-37.5 kg/hL. Lower flake densities indicate more extensive processing and starch gelatinisation. Caution should be used against over-processing. In some studies, feeding low density flaked grains has resulted in lower production because of problems with intake and acidosis.

IMPACT OF PARTICLE SIZE ON STARCH DIGESSION AND MILK PRODUCTION

Maize that is finer ground has a higher digestibility than coarse ground maize. Fine grinding will increase total tract and rumen starch digestion and reduce small intestine starch digestion.

In a USA feeding trial, ground maize (568 micron particle size) or rolled maize (3458 micron particle size) was fed to lactating cows at 5.6kg maize grain per day. When compared to the rolled maize, the ground maize had 8% higher total tract digestibility, 16% more starch was digested in the rumen and 8.5% less starch was digested in small intestine (i.e. smaller particles shifted the site of digestion from the intestines to the rumen) (Figure 13).

GRAIN PROCESSING TARGETS

A fine line exists between maximum rumen performance and an unhealthy rumen environment particularly where a high amount of starch or sugar is being fed. The ideal amount of grain processing will depend on a number of factors including the amount of grain being fed, the frequency, the grain feeding system and the type and amount of forage in the diet.

Dr Mike Hutjens (University of Illinois) makes the recommendation that maize grain in USA dairy cow rations is ground to 1100 microns. He says, “To determine if your dry maize averages 1100 micron, take a cup of it and sift through a baker or kitchen flour sifter. If 2/3 of the grain passes through the screen, it is about 1100 microns”.

Processed maize grain will hold its quality for long periods when stored in a clean, dry place.

TIME BETWEEN PROCESSING AND FEEDING

A recent market research survey showed that 28% of New Zealand dairy farmers in Canterbury and the North Island have an in-shed feeding system. The key benefits and limitations of in-shed feeding systems are shown in Table 9.

### Table 9: Benefits and limitations of in-shed feeding systems

<table>
<thead>
<tr>
<th>BENEFITS</th>
<th>LIMITATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>High utilisation with energy dense feeds.</td>
<td>Milk returns can be variable depending on the payout and the milk solids response.</td>
</tr>
<tr>
<td>More accurate dispersion of minerals to every cow.</td>
<td>At times it can be hard to source some concentrate feeds. (e.g. during a drought).</td>
</tr>
<tr>
<td>With new meal feeding technology individual cows can be allocated feed depending on their milk production level.</td>
<td>Feeding concentrates in the shed can, depending on the feed cause unsettled milking (flies, cows not wanting to leave shed etc.).</td>
</tr>
<tr>
<td>Minimal labour. It is relatively easy to adjust feeding rates and cows can normally be fed by simply pushing a button or pulling a cord.</td>
<td>Cows cannot be stood off pastures and it is impossible to feed large quantities of feed or forages through a meal feeding system. Feeding dry cows can be a hassle.</td>
</tr>
<tr>
<td>Every cow has the opportunity to eat an equal amount of feed.</td>
<td>Intake is limited to a maximum of 4-5 kg/DM.</td>
</tr>
<tr>
<td>Repairs and maintenance costs are typically very low.</td>
<td>Due to the price per unit of energy farmers need to achieve greater milk response rate per kgDM fed for concentrates when compared to forages.</td>
</tr>
</tbody>
</table>

![Figure 14. Effects of grinding on the site and extent of maize starch digestion](image-url)
COST OF IN-SHED FEEDING SYSTEMS

The approximate capital cost of a meal feeding system including a hammer mill for a 60-bale shed is $70,000. Costs are as follows:

Table 10. Approximate cost of feeding supplements through a meal feeding system

<table>
<thead>
<tr>
<th>Costs</th>
<th>$/YEAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest ($80,000 @ 6%)</td>
<td>$4,800</td>
</tr>
<tr>
<td>Depreciation (assume 20 year life)</td>
<td>$4,000</td>
</tr>
<tr>
<td>Repairs and maintenance</td>
<td>$700</td>
</tr>
<tr>
<td>Power</td>
<td>$2,000</td>
</tr>
<tr>
<td>Total</td>
<td>$11,500</td>
</tr>
<tr>
<td>Cost per kgDM (assuming 200 tDM/year )</td>
<td>5.75 c/kgDM</td>
</tr>
</tbody>
</table>

SUPPLIERS OF IN-SHED FEEDING SYSTEMS

There are a large number of suppliers of in-shed feeding systems in New Zealand. The table below includes some suppliers, but there are many others.

Table 11: In-shed feeding system suppliers in New Zealand

<table>
<thead>
<tr>
<th>COMPANY</th>
<th>WEBSITE</th>
<th>PHONE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced Feed Solutions Ltd</td>
<td><a href="http://www.advancedfeedsolutions.co.nz">www.advancedfeedsolutions.co.nz</a></td>
<td>03 215 9437</td>
</tr>
<tr>
<td>Central Silo Systems Ltd</td>
<td><a href="http://www.centralsilosystems.co.nz">www.centralsilosystems.co.nz</a></td>
<td>06 358 5805</td>
</tr>
<tr>
<td>Corohawk</td>
<td><a href="http://www.corohawk.co.nz">www.corohawk.co.nz</a></td>
<td>0800 763 555</td>
</tr>
<tr>
<td>Permbrand SI Ltd</td>
<td><a href="http://www.permbrand.co.nz">www.permbrand.co.nz</a></td>
<td>03 347 3171</td>
</tr>
<tr>
<td>PPP Industries Ltd</td>
<td><a href="http://www.pppindustries.co.nz">www.pppindustries.co.nz</a></td>
<td>0800 901 902</td>
</tr>
<tr>
<td>REL Group (Integrated Farming Solutions)</td>
<td><a href="http://www.relgroup.co.nz">www.relgroup.co.nz</a></td>
<td>03 302 7305</td>
</tr>
<tr>
<td>Sonoma Enterprises</td>
<td><a href="http://www.sonomaenterprises.co.nz">www.sonomaenterprises.co.nz</a></td>
<td>09 551 0959</td>
</tr>
</tbody>
</table>

SOURCING MAIZE GRAIN

There are a significant number of grain companies who can supply whole or processed maize grain. Talk to your local maize planting or harvesting contractor or call 0800 PIONEER (0800 746 633) to find the supplier closest to you.

Some farmers are choosing to grow their own supply of maize grain on farm or a run-off. Alternatively the crop can be harvested as earlage or high moisture corn. The latter two products are not suitable for feeding in most meal feeding systems.

ECONOMICS OF GROWING MAIZE GRAIN

The cost of growing maize grain is shown in Table 12. Storage and processing costs must be added to give an estimated total cost per kgDM maize grain.

Table 12: Estimated cost per kgDM for a dairy farmer growing their own maize grain 2012/13

<table>
<thead>
<tr>
<th>INPUTS</th>
<th>INDICATIVE COSTS ($/ha)</th>
<th>MY COSTS ($/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil testing</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Base: Lime @ 1 t/ha</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Base fertiliser (300 kg/ha) + application</td>
<td>290</td>
<td></td>
</tr>
<tr>
<td>Cultivation</td>
<td>360</td>
<td></td>
</tr>
<tr>
<td>Pioneer® brand 34P88® 39,000 seeds/ha</td>
<td>400</td>
<td></td>
</tr>
<tr>
<td>FAR levy</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Seed insecticide treatment (Poncho®)</td>
<td>130</td>
<td></td>
</tr>
<tr>
<td>Starter fertiliser 250 kg/ha DAP+ application</td>
<td>270</td>
<td></td>
</tr>
<tr>
<td>Planting</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>Pre-emergence weed control</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>Post-emergence weed control</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>Side-dressing 250 kg/ha urea + application</td>
<td>210</td>
<td></td>
</tr>
<tr>
<td>Spraying (two applications)</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>Harvest: Combine</td>
<td>380</td>
<td></td>
</tr>
<tr>
<td>Interest (10% for 8 months)</td>
<td>140</td>
<td></td>
</tr>
<tr>
<td>Total costs (inputs + interest)</td>
<td>$2625</td>
<td></td>
</tr>
</tbody>
</table>

Table 12 continued on next page.
Maize grain is an excellent supplementary feed option for New Zealand dairy farmers. For more information on any aspect of feeding, processing or storing maize grain, or if you are considering growing a crop yourself talk to your local Pioneer representative.

### REFERENCES

PLEASE CALL YOUR GRAIN OR FEED Supplier TODAY