Best Management Practices for Growing Maize on Dairy Farms

DairyNZ

Environment Waikato REGIONAL COUNCIL

FAR

PIONEER BRAND · SEEDS

Plant & Food RESEARCH RANGAHAU AHUMĀRA KAI

Acknowledgements

The project group gratefully acknowledge the individuals and organisations listed below for the time, knowledge and/or funding they have contributed.

Funding	MAF Sustainable Farming Fund Dairy NZ Environment Waikato Foundation for Arable Research Genetic Technologies LTD
Authors	Chris Glassey - Dairy NZ Gabriele Kaufler - Environment Waikato Mike Parker - Foundation for Arable Research Andrea Pearson - Foundation for Arable Research Ian Williams - Genetic Technologies Paul Johnstone - Plant & Food Research
Design and Print	BNS Design & Print Ltd

Best Management Practices for Growing Maize on Dairy Farms

"Maize is a vital crop for many New Zealand dairy farmers; it also represents a significant investment in time and resources. This booklet aims to give farmers the tools that they need to extract maximum value from this investment, providing the most topical information on maize crop preparation, management and harvest, in one easy to access resource."

Contents

Published by Foundation for Arable Research (FAR) September 2009
Tel: 03 325 6353 www.far.org.nz

ISBN: 978-0-9864533-3-5

Version 1 - September 2009

1. Improving pastoral dairy farming using maize silage

Maize grown on dairy farms

Can:

- Add value to a farms feed supply
- Help mitigate climatic risk
- Extract excess soil nutrients from high fertility effluent paddocks

Must be:

- Fed to fill genuine feed deficits for economic responses
- Well managed to reduce feed costs and wastage

Pasture is the major component of the NZ dairy herd's diet; however, opportunities exist to improve profit through the strategic use of maize silage.

The pastoral dairy farm is a balance between pasture supply and cow demand, which must be maintained to achieve efficient conversion of feed into milk and profit. Unless well integrated with pasture supply and feed demand, extra feeds such as maize silage, will produce extra milk, but not always extra profit.

To use maize silage profitability farmers must identify what they are trying to achieve through its use. This requires working out the key limiting factors for running an efficient and profitable grass-based system and whether changes are in line with their goals. This can be done in conjunction with a farm consultant or forage specialist.

Important factors for improving pastoral dairy farming using maize silage are:

1. Ensure that the highest responses are gained from the feed eaten

A key driver of response to additional feed is energy deficit, the difference between energy demand and the actual energy supplied.

Cows of high breeding worth ($BW), at high stocking rates and with lactations longer than 260 days, are more likely to be in energy deficit, and will be more responsive to additional feeds such as maize silage. Cows respond best to extra feed if the farm has a genuine feed deficit, created through calving earlier, more days in milk or carrying more cows per hectare.

If all of the additional energy provided by supplement is converted into milk, the maximum possible response is 13 g MS/MJ metabolisable energy (ME). This is equivalent to 137 g MS/kg DM maize silage (assuming maize silage is 10.5 MJ ME/kg DM). In practice, responses are usually much lower than this due to feed losses in transport, storage and feeding, the substitution of supplement for pasture, the partitioning of energy into liveweight gain (LWG) or the maintenance of extra cows.

Trials in New Zealand have found production responses to maize silage between 32 g MS/kg DM and 178 g MS/kg DM. The highest response came from more days in milk created by feeding maize silage in a year affected by a dry summer. Analysis of more than 600 NZ dairy farms found on average, that supplements fed added only 50 g MS/kg DM to annual milk solids per cow and 96 g MS/kg DM to annual milk solids/ha. With such a variation in response possible, attention to detail is required in order to turn additional feed into additional profit.

2. Source the maize at the right price

If maize silage can be sourced, stored and fed for 22 cents/kg DM, a response of at least 50 g MS/kg DM fed is required just to pay for the maize silage (Based on the 2009 payout of $4.55/kg MS). However, with responses ranging from 32 to 178 g MS/kg DM the value created could be as low as 15 cents/kg DM or as high as 64 cents/kg DM.

Maize cost can vary depending on where and how it is grown. If maize is grown on the dairy platform in an effluent paddock, the cost could be as low as 12c/kg DM before storage. Maize purchased off-farm is generally more expensive. However, allowance needs to be made for the value of the extra nutrients bought in with the maize and a reduction of risk due to maize being grown off the dairy platform. As a rule of thumb, DairyNZ recommends that farmers will be more likely to retain their profitability by limiting the cost of supplementary feed delivered to the farm to less than 5% of milk solids payout in that year (e.g. 5% of $4.55/kg MS = 23 cents/kg DM).

On-farm management of feed potentially causes the greatest variation in feed costs. For example a poorly managed stack can cause wastage amounting to a 30% increase in feed costs. Also, grass wasted through feeding maize silage at the wrong time can result in reduced profitability. Minimising losses during storage and feeding out is covered in depth in chapter eight.

3. Use maize silage to mitigate climatic risk

New Zealand's climate and soils make for challenging farming. All areas of New Zealand have times of the year when the supply of quality grass for milk production is unreliable. The higher a farm is stocked, the greater the impact of these periods. It is important to identify these periods and any potential benefits of feeding maize silage:

- If the soil is very wet in winter, feeding maize silage on a feed pad may mean that higher cow numbers can be carried to take advantage of excellent summer grass growth.
- Or, if the farm has regular dry autumns which shorten lactation, maize fed at the end of lactation to restore cow condition and build pasture cover will help overcome this risk.

4. Limit the negative impacts of pasture substitution

Feeding supplements reduces the amount of time a cow spends grazing and reduces its desire to eat pasture. If the farm is entering a time where a grass surplus might occur and therefore pasture quality may decline (e.g. spring), then feeding maize silage will waste money. However, if that substituted grass can be carried through to a predicted feed deficit (e.g. winter or early spring), then feeding maize silage is more likely to be profitable.

5. Use maize silage to extract excess nutrients from effluent paddocks

Effluent paddocks offer an opportunity to grow maize silage utilising the nutrients from past effluent applications. They often carry N and K surplus to the requirement for pasture production and therefore have increased risk of N leaching into the ground water and occurrence of metabolic diseases such as milk fever and grass staggers. A maize crop removes large amounts of N and K and therefore reduces these risks. Maize silage grown on effluent paddocks yields well with significantly reduced fertiliser inputs and therefore less cost to grow.

6. Use maize silage to re-grass paddocks

Maize silage acts as a “break crop” for controlling perennial weeds such as couch and kikuyu, as well as reducing the populations of the clover root knot nematode and the white fringed weevil.

In summary, growing maize on dairy farms can be an important component of planned improvement of a farm’s feed supply, either directly through the high potential DM yield of the maize crop itself and/or through the improved pasture resulting from a planned cropping rotation.

2. Liaising with your contractor and technical advisor

Growing maize requires a range of operations:

- Most dairy farmers will need contractors to assist with some or all of these processes
- Some contractors and technical advisors will offer a crop management service
- Communication and good planning are key to working with contractors and technical advisors

Growing maize requires a range of operations from cultivation through to harvest. Most dairy farmers won't have the specialist equipment required for growing maize and will therefore need to employ contractors for these tasks.

For those with limited time or experience, technical advisors from a range of merchant companies are available to offer crop management services and/or advice. There are specialist contractors and advisors who concentrate on only one aspect of maize production (e.g. spraying or fertilisers). Others provide a complete service from sowing to harvest.

The key to working with contractors and technical advisors is good communication. Most have several hundred clients requiring the same service at much the same time.

Notice of your intentions well in advance and then regular updates will improve the service they can provide. You will need to talk with your contractor and technical advisor regarding your specific requirements, which may include:

1. Spraying

Your spray contractor will need to know your sowing date so that they can plan when to spray out pasture, and later when herbicides will be required for the crop. Monitoring (chapter seven) will help determine if post emergence herbicides will be needed.

2. Cultivation

Your cultivation contractor can advise and outline costs of cultivation methods; however, this will need to be done well in advance of the projected planting date. (chapter five – Soil Preparation)

3. Sowing

Your sowing contractor will need advance warning of both your intended sowing date and your fertiliser program. Seed Companies and Rural Supply firms will give advice on a suitable maize hybrid for your site, sowing date and planned harvest date. You should also discuss options regarding seed treatment for pest control.

4. Fertiliser

Ensure you have a recent soil test, collected from 0-15 cm deep from your intended maize paddock. Paddocks coming out of long term pasture can supply up to 300 kg N/ha just from soil organic matter, so soil test for mineral nitrogen (0-60 cm) to determine post sowing urea applications. Technical advisors and fertiliser companies can organise soil tests and develop fertiliser plans. (chapter seven - Crop Monitoring).

There are a number of different methods of fertiliser application; bulk spreader for base fertiliser, sowing contractor for fertiliser

applied through the drill, post emergence N - often referred to as side-dressing (knifing or broadcasting urea into the soil six to eight weeks after sowing). Your technical advisor will assist you in determining the best method for your conditions. (chapter six Maize Nutrients)

5. Harvesting

Maize harvesting and stack building is an extremely busy and difficult time for contractors; with large hectares to harvest, a short time frame and often adverse weather to contend with.

Maize is normally harvested between 30 to 40% dry matter. Let your contractor know your preference well in advance.

Determining maize silage maturity in the field requires considerable experience. Generally harvest contractors will monitor crop maturity and determine harvest time.

Technical advisors will also give guidance if required. (chapter seven)

Remember that stack sites and access areas must be prepared before harvest. Aim to get this done early in case the crop matures faster than expected.

Post harvest planning e.g. sowing new pastures, is also crucial to continued success. Again your technical representative will be able to assist you with the best options for your site.

3. The drivers of maize yield

Maize yield is affected by many factors:

- Sowing location, sowing date, hybrid choice and population will all influence the potential yield of the crop
- Potential yield can be reduced by weed and pest presence, moisture stress, disease and nutrient limitations

Maize crops behave in a very predictable manner, making it a very attractive crop for researchers to work with. Therefore the drivers of maize yield are well understood.

Potential yield (the maximum possible yield provided there are no limitations due to; weed pressure, drought, water logging, nutrients, disease, and soil structure etc) is driven by radiation interception.

Radiation (sunshine energy) is absorbed by the crop according to how much is coming in, and how much green leaf area is available to intercept it. The radiation is converted to biomass at a rate of 1.6 T DM/ha for every 100 MJ of radiation intercepted. Maize is one of the most efficient plants at doing this.

Temperature is another factor which also influences potential yield, because it affects the rate of development (time to various growth stages like leaf emergence and silking). Temperature is used to calculate 'Growing Degree Days' (GDD's). Warmer temperatures mean crops reach maturity faster.

To maximise potential yield, we need to maximise radiation interception. There are four main factors that drive this; location, sowing time, hybrid and population.

1. Location

Temperature and radiation are different around the country. The highest maize yields are often achieved in Gisborne, because of the high radiation and long growing season in that region. Often our growing location is fixed, but if you are thinking of leasing or buying land to grow maize on, you should investigate the climatic conditions at the site.

2. Sowing time

This affects radiation interception, as radiation changes during the year. Radiation peaks in late December, so aim to sow your crop so that you have full canopy cover by this stage, to maximise the use of this radiation.

In general, earlier sown crops tend to yield better than later sown crops (Figure 1). However sowing time needs to be balanced against many other factors such as; frost risk, soil conditions and any pasture silage that you wish to harvest off the paddock.

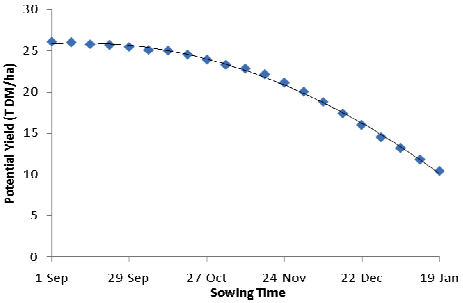


Figure 1. Effect of sowing time on potential yield for a medium season maize silage crop grown in the Waikato.

3. Hybrid

There are many different maize hybrids available. The main differences between hybrids are:

- The number and size of leaves (which affects green leaf area and hence radiation interception).
- Crop maturity or the number of GDD's before the crop is ready to harvest.
- Their ability to cope with stresses such as disease or drought.

Your choice of hybrid will ultimately depend on; where you are, when you want to sow, and when you want to harvest. Your seed sales representative can help you select a suitable hybrid.

As a general guide, short season hybrids tend to yield less because they have fewer and smaller leaves than long season hybrids (intercept less radiation). They also need fewer GDD's to reach maturity, so they are in the ground for fewer days, and hence absorb less radiation.

4. Plant population

Population affects radiation interception as more plants means more leaf area. Typical populations for maize silage is 100 to 120 thousand (K) seeds per hectare (there are 80 K seeds in a bag) and your seed sales representative will advise you on the best population for your situation. Final populations are normally 5 K/ha less than what was originally sown.

Other factors affecting potential yield
Potential yield assumes there is no limitation to the stresses that commonly affect maize yields. In reality, this is seldom true.

Weed pressure can reduce maize yield by up to 30%, make harvest difficult and contaminate silage. Monitor crops for weeds and take action early as many weeds can grow faster than maize seedlings.

Drought will reduce maize yield by 22 kg DM/ha for every 1 mm of potential soil moisture deficit (the difference between what a crop needs and what it gets). Because maize has deep roots (up to 1.8 m), few maize crops are irrigated except if grown in dry environments and/or on shallow soils.

Water logging reduces the plant's ability to take up nutrients, and creates a toxic soil environment for plant roots, since the soil cannot 'breathe' and release gases created by soil microbial activity. Prolonged water logging can cause large losses in maize yields.

The **nutrient** requirements for maize will be covered in chapter six. The nutrient most likely to limit maize yields is nitrogen. Soil nitrogen is generally low in paddocks with a long history of cropping, but very high in paddocks coming out of long term pasture.

The main leaf **diseases** of maize are common rust, eyespot and northern corn leaf blight. Severe infection can reduce yields by 30%. Only in very disease prone conditions (warm and humid, together with a hybrid of lower disease resistance) will the application of fungicides be economically beneficial.

Pests can also affect yield. Argentine Stem Weevil (ASW), Greasy Cutworm and Black Beetle can be a problem particularly if direct drilling or strip tilling. (chapter seven - Crop Monitoring)

Soil structure tends to deteriorate with repeated cultivation. Compaction reduces soil aeration and aggregation, affecting the ability of plant roots to extract water and nutrients from the soil. Paddocks formerly in long term pasture generally have good soil structure.

4. Site selection

- Paddock selection is important in terms of:
  - Access for large maize machinery
  - Yield potential
  - Cost of production and harvest
  - Environmental impacts
- Consult with your contractor(s) before finalising your site selection

Many dairy farmers use maize grown on farm as part of their pasture renewal programme. However, not all such paddocks are suited for maize production.

- Very steep paddocks (often also with wetter gullies) not only make cultivation and harvesting difficult and hazardous, but also tend to not yield as well.
- Low lying wetter paddocks will often mean delays in cultivation after adverse weather. Again these often do not yield as well, unless drought conditions prevail.
- A paddock which is wet with a grass sward, acts as if 10% wetter when the structural strength of the sward is removed by cultivation.
- Wet paddocks risk a loss of soil structure under cultivation which in turn leads to lower yields.

Many long term effluent paddocks have high N and K levels and therefore are ideal for growing a deep rooting crop of maize often without using any bagged fertiliser (chapter six). While this often means herds have to walk further while the effluent paddock is out of rotation, the opportunity for reduced growing costs and environmental benefits should be considered. Many long term dairy pastures also have a fertility level that means N fertiliser inputs for maize crops sown from pasture can be reduced without maize yield reductions.

It is also important to consider the location in terms of protection of sensitive areas i.e. streams, lakes, wetlands and drains (chapter five)

To grow high quality maize silage on farm for the least cost, consider the factors that make a contractor's job speedy and efficient.

Paddock access is also very important, the distance from the paddock to stack will reflect in the harvest cost. Cartage costs from distant runoffs will be greatest; however narrow, rough farm tracks with poor access will also mean higher costs.

Maize cultivation equipment and harvesters are wide, long, and heavy, requiring gate widths of at least 4 m with ample turning room, unless fences can be dropped. Bridges or culvert crossings need to be of sufficient strength to hold the weight of heavy vehicles and (at harvest) their loads. Low hanging overhead wires should be raised, or at least temporarily removed.

Consult your contractor prior to finalising your site they can assist you in selecting the best paddock to sow in maize.

5. Soil preparation

- The soil provides water and nutrients to the crop, but poorly managed cultivation can damage soil and affect crop yields
- Factors to consider are:
  - Soil type and suitability for cultivation
  - Adjacent sensitive areas (e.g. waterways)
  - Quality of the final seed bed (uniformity of surface and aggregate size)
  - Intensity of cultivation, including the pros and cons of ploughing

The soil provides water and nutrients for plant growth; therefore, a healthy (structurally sound and biologically active) soil is important for crop production.

Cultivation serves many purposes in crop establishment.

- Creating a uniform seed bed
- Relieving compaction (e.g. from stock treading) and improving aeration
- Incorporating residues and weeds
- Warming and drying the soil
- Incorporating lime and fertilisers

Poorly timed or managed cultivation can damage soil, cause compaction and erosion problems, and ultimately affect crop production. This is most likely to occur when the soil is too wet or too dry.

Some of the key steps for successful cultivation are outlined here:

1. Understand your soil resource

How your soil responds to cultivation will depend on the soil type and texture, plus any limitations it may have such as risk of erosion and water logging. Your regional council can help you to identify your soil type and any limitations it has for cropping.

2. Identify sensitive areas

Soil can run off into water ways during high rainfall events, creating erosion and water quality issues. Most regional councils have guidelines for how close you can cultivate to a waterway. If you need to leave a buffer zone around the edge of your cultivated zone, don't spray it out as weeds will establish instead. Rank grass vegetation will act as a filter and help trap potential run off.

3. Soil surface

Maize seed is normally sown around 5 cm deep. An uneven soil surface (undulations, ruts etc) makes it difficult for the planter to place the seed at a uniform depth, resulting in variable emergence. Very cloddy soil or large ruts can cause the planter to bounce, causing variability in seed depth and spacing.

4. Aggregate size

Maize does not need a very fine seedbed. It is a large seed and seed to soil contact is generally sufficient for germination, except in very cloddy soils. Light rolling after sowing may help improve the seed-soil contact, seal in moisture and reduce the risk of wind erosion.

5. Minimal cultivation

Excessive cultivation weakens the soil and accelerates loss of soil organic matter. Keep cultivation to a minimum and avoid cultivation when the soil is too wet or too dry.

6. Should I plough?

Ploughing is a quick effective way to bury plant residues that might otherwise impede secondary cultivation or cause weed problems. However a comment we often hear from dairy farmers is that maize is 'hard on the soil' and one of the main causes of this is associated with ploughing.

Pastoral farmers invest a lot of money in fertiliser to improve the nutrient levels in the top 7.5 cm of their soil. If that topsoil is then buried at 20 cm by ploughing, then subsequent soil tests will show lower fertility. Those nutrients are still there but now below the 7.5 cm soil sampling depth and out of reach of the new grass trying to establish after maize.

Talk with your contractor about alternatives to ploughing, such a discing. Be aware that you may need a longer fallow period (time between spraying out pasture and first cultivation pass), but you need to balance this against the long term damage to your soil fertility. Conversely, ploughing may be a remedial option if your topsoil nutrients are too high (chapter six).

There are other reduced tillage options for maize such as strip tillage and direct drilling, but these require more attention to details and are best suited for specialist maize growers.

6. Maize nutrient requirements

- Maize requires substantial nitrogen (N) and potassium (K), both of which are present in large amounts in dairy soils
- Up to 300 kg N/ha is released from soil organic matter when high fertility dairy pastures are cultivated
- Maize is unlikely to respond to K fertiliser unless soil K test levels are very low. Replacement K fertiliser can be applied after harvest to avoid luxury uptake by the maize crop
- Soil test for N before applying post emergence N fertiliser to determine if any is required
- Dairy effluent can be used as a nutrient source for maize, provided that the crop requires the nutrients and good effluent management practices are followed

Cropping and dairy farmers often have different approaches to fertiliser management. Cropping farmers will estimate what the crop needs, measure how much is already available, and then determine how much extra is needed. Pastoral farmers are more focussed on reaching optimum levels of soil fertility, then maintaining them using a nutrient replacement policy.

A nutrient replacement approach for maize grown on dairy farms does not work well, for two main reasons.

- Maize can access nutrients from right through the soil profile, not just the top 7.5 cm. Deeper nutrients are available to maize but not to grass, so why not use them?
- Cultivation of pasture paddocks releases large amounts of nutrient, particularly nitrogen.

The upside of both is a huge saving in fertiliser inputs.

1. Nutrient uptake by maize silage

The average maize silage crop contains about 1.1% nitrogen (N), 0.2% phosphorus (P) and 1.2% potassium (K). This means a maize silage crop yielding 20 T DM/ha will take up around 220 kg N, 40 kg P and 240 kg K. It does not mean this is how much fertiliser we need to apply. Let's go through each of these nutrients separately

Nitrogen (N)
Of all the nutrients used on cropping farms, N is most likely to limit maize yields and is typically the largest fertiliser input. Typical N inputs for maize would be 20-50 kg N/ha applied at sowing and around 100-200 kg N/ha applied as urea six to eight weeks later (post emergence N, sometimes referred to as side-dressing).

These inputs are generally not needed for maize grown in dairy paddocks coming out of long term pasture. Over the past two seasons, we have monitored maize grown in nine dairy paddocks, both with and without a history of effluent application. Results have been consistent. We found no response to N fertiliser at any site because we measured up to 300 kg N/ha released by the soil, enough to meet crop requirements.

You may still chose to apply a small amount of fertiliser at sowing, however, in the first year out of grass there is no need to apply further N fertiliser to maize crops grown in dairy pastures. If in doubt, get your fertiliser rep to collect a deep N soil sample (60 cm)

for mineral N before you apply any post emergence N. The AmaizeN N fertiliser forecaster can help interpret the results.

Phosphorus (P)
How can such a huge crop use such a small amount of P? Phosphorus is used by plants for root growth, nutrient uptake and grain development. Maize is highly efficient at using P. The removal of 40 kg P/ha by a maize crop will barely register in a soil test. Your cultivation practices are likely to have a bigger impact (chapter five).

Most growers apply a small amount of P at sowing. Recent trials on maize silage grown on dairy farms showed that even though the seedlings looked smaller where no P fertiliser was used, there was no effect on final yield.

How much P fertiliser you apply will depend on your soils' Olsen P status and whether you want to increase, maintain or decrease it. Discuss your long term plans for the paddock with your fertiliser rep.

Help, my crop has turned purple!!

This purple discolouration sometimes seen in maize seedlings is often attributed to P deficiency, but is more likely due to some other stress such as the cold or wet. Certain hybrids are more prone to purpling. In the vast majority of cases, the crop will grow through the stress with no permanent effects.

Potassium (K)
Maize silage is around 1.2% K (a 20 T DM crop uses 240 kg K) but unless you have low soil K levels (<5 MAF K units in 0-15 cm), you are unlikely to see a yield response to K fertiliser. Few dairy paddocks will have low K levels.

If you wish to replace the K that is removed by the crop, you may not have to replace it all, as maize will extract K from the whole soil, not just the topsoil. Also be aware that maize can take up extra K if it is available (luxury uptake). To avoid this, you could apply the replacement K fertiliser after the crop, rather than before.

2. Soil tests - the basis of fertiliser plans

There are two soil tests regularly used for maize.

1. Basic soil test (0-15 cm) for pH, Olsen P, K, Ca, Mg etc.
2. Deep N (0-60 cm) for mineral N

Basic soil tests are normally collected prior to cultivation, to plan capital or pre-plant fertiliser inputs. The results will be lower than a 0-7.5 cm test because most nutrients are concentrated in the topsoil. We sample deeper for maize, as its roots are deeper than pasture. Be aware that cultivation will redistribute nutrients through the soil, so subsequent tests may give different results irrespective of any crop nutrient uptake or fertiliser inputs.

The deep N coring depth is 0-60 cm because N can move to this depth and beyond in the soil, and maize has deep roots to access it. This test should be done after cultivation and preferably as late as three to four weeks after sowing (collect from the mid row to avoid sowing fertiliser). The results can be used to refine your N fertiliser plan, however if the paddock has just come out of long term pasture, the test will probably show that you don't need any more N.

Your fertiliser rep can arrange soil sampling and interpretation of both the basic and deep N tests. Deep N results can be run through AmaizeN, a fertiliser N forecasting tool developed for maize.

3. Can I use dairy effluent for fertiliser?

In short, yes. The ratio of NPK in maize is similar to that found in dairy shed effluent, so they make a good match. Early results suggest that about half of the nutrients applied as effluent are available to the maize crop in the year of application. However, as with any fertiliser, we need to establish whether the crop or soil requires these additional nutrients.

If the paddock is just out of grass, the soil can supply plenty of N and further additions through effluent are probably not needed. Paddocks with a history of cropping (e.g. a dedicated cropping block or run off) are most likely to benefit from effluent application.

If you are applying effluent to your maize crop, then follow good practice.

- Test your effluent for nutrient content prior to application, so you can calculate an appropriate application rate. However, be aware that this will be a rough estimate as effluent nutrient content is highly variable. The maximum loading to cropping ground in the Waikato is 200 kg N/ha/year as effluent.
- Check how much is actually applied. Put containers in the paddock during application and measure the depth. You can multiply the volume applied by the nutrient content to determine how much total nutrient was applied.
- Ensure there is no ponding or run off during application. You may need to make multiple passes to apply the amount you want.

4. Growing maize on the effluent block

Long term application of effluent increases soil K levels. Pastures with high K levels can cause metabolic problems in cattle. Maize can be successfully grown on effluent blocks with high soil fertility without the use of additional fertiliser.

Maize will take up K from the soil and if it is fed out around the farm, then the nutrients will be redistributed around the farm. If the maize is fed on a feed pad with wash down into the effluent system, then the nutrients will end up back on the effluent block.

Soil cultivation associated with growing a maize crop can redistribute nutrients through the soil. Ploughing will move topsoil nutrients to depth, so this may be an option if your soil K levels are excessively high.

7. Crop monitoring

- Monitoring is an important part of good management to maximise yield
- A good monitoring programme should include:
  - Weeds, pests and diseases
  - Soil N sampling
  - Soil moisture if irrigating
  - Crop maturity
- Contractors and technical advisors can undertake some or all of this monitoring

In order to anticipate or rectify problems and maximise yield it is necessary to monitor crops regularly, particularly in the first two months of growth. For the busy dairy farmer, technical advisors and some contractors will provide this service.

1. Emergence

Paddocks need to be checked for slugs, bird, rabbit and rat damage. Slugs are generally not a problem where intensive cultivation has been carried out but can do serious damage during wet weather and if reduced tillage practices have been used. Leaf damage and slime trails are a good confirmation of slug presence. Bird and rat damage is characterised by plants pulled and the seed embryo eaten. Missed planted rows or poor population areas should be noted at this time and if practical, rectified.

2. Weeds

Weeds in maize crops can cause significant yield loss and moisture activated pre-emergence herbicides generally perform very well. However, dry conditions after application, delayed application or perennial weeds can mean that further post emergence applications are required. Choice of chemical will depend on what weeds are present and their growth stage, therefore monitoring is vital. Paddocks out of long term pasture often have a greater broad leaf weed seed bank than grass weeds and therefore omitting a grass weed herbicide (chloroacetamide) from the mix might be worthwhile. However, run out pastures often have (for example) summer grass weed seed present and therefore the addition of a chloroacetamide would be necessary.

3. Emergence to four leaves (V4)

Note four leaves with clearly visible collars.

Continue monitoring for slug and bird damage but also to check for greasy cutworm and weeds. Greasy cutworm feed at night by typically cutting and felling maize plants. Their presence can be confirmed by digging around the base of freshly felled plants or examining plants near dusk. Spraying with a synthetic pyrethroid insecticide at dusk gives good control.

Greasy cutworm

Deep soil (0-60 cm) mineral N testing can also be carried out while pest and weed monitoring (chapter six) to plan post emergence fertiliser N application.

4. Six leaves with visible collars (V6)

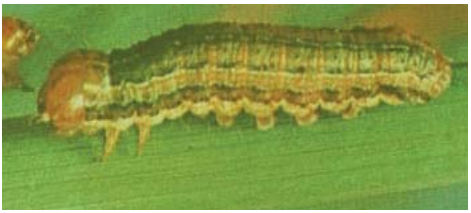
From V6, the crop grows very rapidly and with time eliminates vehicle access into the crop. High clearance sprayers or aerial application become the only options.

If further N fertiliser is required, then make sure it is applied by this growth stage. Monitoring can also be done during fertiliser application and sometimes post-emergence herbicide applications are also applied with the fertiliser.

5. Mid to late December

Leaf diseases (if warm and humid) appear during this time. Monitoring for common rust, eyespot, and northern corn leaf blight (more common in long term maize land) is important if less resistant hybrids have been used. Fungicides will give control but are seldom used unless environmental conditions are particularly favourable to disease. Generally around the 20-30th December is the time to check for army worm caterpillar especially if crops are weedy. Note that corn earworm often appears in January as the cobs are pollinated. They are generally controlled by parasitic wasps. Corn earworm should not be confused with armyworm.

Armyworm caterpillars - green, then greenish brown when older.



Corn earworm.

6. Irrigation

While generally not practised in most North Island dairy regions, irrigation is common in Canterbury. Inadequate moisture (when the soil moisture falls below half the soil water holding capacity) at any growth stage can reduce maize yield. It is advisable to run a water budget or schedule based on 50% of plant available moisture linked to weekly

evapotranspiration rates (ET). Moisture stress can also result in a lack of synchronisation between pollen shed and silking at pollination.

7. Silking date

Silking date is the date when 50% of the plants are showing silk at the tip of the young embryonic cob.

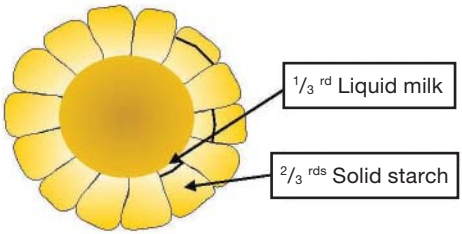
The date when 50% of the plants are silking (refer to photo) should be noted. Maize generally takes 50-55 days from this time to reach two thirds milkline, an important indicator of crop maturity.

8. Three weeks prior to harvest

It is vital that crops are checked for harvest maturity. The AmaizeN calculator and 50% silking date will greatly aid in determining when to start frequent monitoring. Good quality maize silage is best made when the whole plant Dry Matter (DM) is between 30 and 40 %. If harvested at less than 30% DM, silage in the stack will be wet resulting in high stack leachate, this leachate represents nutrient loss. If greater than 40% DM, stack compaction and air exclusion is much more difficult.

In-field estimation of crop DM requires considerable experience as; changes in soil type, topography, proximity to trees or hedges, the hybrids cob to stover (vegetative parts) ratio and time of day, all need to be taken into account. However, by examining plants in representative areas good estimates can be made.

One important maturity indicator is the maize kernel milkline, where the milky liquid changes to the harder darker starch line. By simply snapping a cob in two and examining the upper portion's kernels, the milkline can be seen. When the milkline is one third of the way up from the bottom of the kernel the plant is in the 28 to 32% DM range. However, other indicators need to be considered (including those mentioned earlier) such as the hybrid, the husk cover colour, the greenness of the leaves and stem.



Maize kernel milkline.

Most contractors and technical advisors have experience in harvest scheduling. Dairy farmers would be wise to seek their advice in this area.

8. Harvest and post-harvest management

- Once ensiled maize silage deteriorates when exposed to air

  To minimise losses:

  - Carefully consider stack location and prepare the site in advance of harvest
  - Design the stack to minimise the amount of maize exposed while the stack is being fed out
  - Minimise disturbing or damaging the stack face to maintain compaction

Maize silage is full of soluble carbohydrate which while being a great food for cows, is also loved by spoilage bugs, such as yeasts and moulds. Yeasts and moulds need oxygen to survive. The aim of the ensiling process is to get air out of the stack and keep it out until the maize silage is ready to be fed.

1. Storing maize silage

Choosing a site
You need to make sure that the stack is well sited.

- Locate it close to the area where the maize will be fed.
- Ensure that it is far enough away from banks, fences, walls and trees to allow tractors room to run off the stack while they are building it.
- Choose an area which is free draining.
- If you need to lay down a metal or lime pad ensure that this is done in advance and well compacted.
- Bait the area with rat bait for at least two weeks prior to the maize being harvested.
- Consider environmental implications, for example: pollution risk from runoff of stack leachate, distance to waterways, drains and other sensitive areas.

Stack types
One issue to consider is to whether to use a bun (stack) or a bunker. Buns can be located around the farm and are therefore more flexible, whereas bunkers are initially more expensive, BUT have higher compaction rates and therefore less wastage

Your storage contractor will be able to assist on the best method for your farm.

Building the stack
Stack dimension depends on how much maize you are going to stack, how many animals you have and what inoculant you are using. The aim is to build a stack so that when being fed out, as little maize as possible is exposed to air, for as short a time as possible. Therefore, a taller stack is better than lower one and narrower stack is better than wider one. Ideally it should take no more than three days to feed across the stack face, taking out about half a metre each feed.

As the stack is being built make sure that the maize is being layered no deeper than 150 mm deep.

Covering and sealing
Cover the stack with the highest quality cover you can afford, immediately after the contractor has finished rolling the maize silage. Seal around the base of the stack with soil, sand or lime and place tyres over the top of the stack. Ensure that there are sufficient tyres to cover the stack completely, with no gaps between the tyres. If birds are a problem, cover the whole ensiled stack with shade cloth, this is light, cheap and effective.

2. Feeding out maize silage

Starting feeding
Open the stack at the opposite end to the prevailing wind to prevent air getting pushed under the cover. Use a front end loader to create a face. Once the face has been created, chip away from the top of the stack, rather than lifting up from the bottom of the stack face. Do not ram the bucket or silage forks into the face of the stack as this creates shatter and may allow air to penetrate into the maize stack.

Heavy rainfall can also pose a risk if the water gets into the stack creating a pollution risk through leachate.

Face management
Ensure that the face is left tight daily, with no loose material at the base of the stack. A wide mouth shovel and a broom will help prevent this. You do not need to drop the cover down over the face each day. If birds are a problem use shade cloth or bird netting to cover the face of the stack with a few tyres top and bottom to prevent the wind lifting it.

Closing a stack down
Use a front end loader to remove any loose material from the front of the stack, trim up the face using an old chainsaw, and then spray a saturated salt solution over the stack face. Drop the silage cover back down over the face, reseal the base with soil, and place tyres against the covered face. Replenish all the bait stations around the stack and leave the stack until you need to feed out again. It is a simple matter of rolling the cover back up, removing any material that may have become mouldy and feeding out again.

9. Maize forage trading code of practice

- The 'Maize Forage Trading Code of Practice' has been designed to safeguard both the buyer and seller of maize
- Standard protocols for weighing, sampling and testing have been developed for trading on a dry weight basis (kg DM)
- These protocols can be used for determining the total DM yield of your stack for feed budgeting purposes

If you are buying or selling maize silage, you should be aware of the 'Maize Forage Trading Code of Practice', which has been designed to **safeguard** both the buyer and seller of maize. Developed by contractors and industry groups, the code outlines best practice for trading maize forage on a dry weight basis (i.e. kg DM).

To ensure **fair trading**, the following information is required:

- Accurate weight of each truck load
- Representative samples of forage from either trucks or the stack
- Accurate analysis of DM content (%) of the samples

After extensive trials, a standard set of weighing, sampling and testing **protocols** have been developed. The protocols are described fully in the code and are also summarised in the 'Good Practice Guide for the Trading of Maize Forage'.

Even if you are not trading, using the sampling protocols to determine the total DM yield in your stack will be useful for **feed budgeting** purposes. As well as DM%, the samples can also be tested for feed quality or nutrient content.

A recent addition to the code is a standard **purchase contract** that can be used for trading maize forage. Recent market volatility has tested the value of a verbal arrangement, and a signed contract will allow parties to legally formalise their agreement. To provide confidence, security and stability for all parties, we strongly recommend that a formal purchase contract is used.

The complete code, good practice guide and purchase contract are all available from Foundation for Arable Research.

While the code is focussed on maize forage, the same principles apply to other forages such as pasture or cereal silages.

10. Record keeping

- Crop management should be recorded for a number of reasons
- You should make sure that you have copies of crop management records, even if a contractor or technical advisor is managing your crop

There are numerous good reasons for keeping crop management records, these include:

Environmental reporting
All Fonterra suppliers are required to complete nutrient budgets and your maize silage crop should be done as a separate block.

Financial reporting
A 'Cost of Production' worksheet can assist you to calculate the cost of growing your crop.

Diagnosis
If something goes wrong with your crop.

Repeat Results
When you grow a fantastic crop, you will know what was done so you can to do it again!

You may rely on others (e.g. technical advisors or a contractor) for some or all of your crop management. However, you should still make sure you have copies of crop management records. These will be useful if your advisor changes, or you change to another company or contractor.

1. Crop management records to keep

Laboratory tests:
Copies of any soil, plant and effluent analyses including when, where and how the samples were collected and by whom.

Cultivation
When, how, who and any notable soil conditions (e.g. a bit dry, too wet).

Herbicides
For each application record; when, the product(s) used, chemical and water rate, who sprayed, and weather conditions during application (especially wind direction and speed).

Nutrient inputs
For all fertiliser, lime, effluent or other nutrient inputs (e.g. chook manure), make sure you record when, where and how it was applied, the rate and nutrient content of the product, and who applied it.

Crop details
The hybrid, sowing time, plant population and any seed treatment used.

Other inputs
Keep records of application rate and timing of other inputs such as; insecticides, irrigation etc.

Crop monitoring records
Your crop should be regularly checked for; weed, pest and disease pressure, establishment and harvest maturity. Those irrigating may monitor soil moisture and rainfall. Keep records of all crop, soil and weather monitoring.

Harvest
Record the harvest date(s). If you are not weighing your crop, ask your technical advisor and/or contractor for their best estimate of crop yield and DM%. On completion stacks can be easily sampled for analysis of DM% or feed quality. This is done regularly for traded maize (chapter nine) your harvesting contractor should be able to arrange this.

11. Resources and further information

DairyNZ

www.dairynz.co.nz

Ph 0800 4 DAIRYNZ (0800 4324 7969)

Resources Available include:
Feed information Sheet - contains all the feed supply and demand numbers required for daily and annual feed requirements of dairy cattle

FeedPlan Pro - is designed for farmers and consultants wanting a simple, quick and visual way of feed budgeting and monitoring.

Environment Waikato

www.environmentwaikato.govt.nz

Ph 0800 800 401

Resources Available include:
Fact sheets and brochures on nutrient, soil and effluent management, website provides information on; best management practices, tools, environmental monitoring data as well as various technical reports. Staff are able to provide farm specific guidance and advice related to land management and waterway protection. Workshops and Field days on best management practice.

Foundation for Arable Research

www.far.org.nz

Ph 03 325 6353

Resources Available include:
AmaizeN Fertiliser Forecaster, Maize Action Newsletter, Arable Updates, Cost of Production Worksheet, Maize Forage Trading Code of Practice, Field days and Workshops, Grass Weed Management - the Ute Guide

Pioneer Brand Products

www.pioneer.co.nz

Ph 0800 PIONEER (0800 746 633)

Resources Available include:
Pioneer Maize Harvest Guide 2006, Bunker Calculator, Silage harvest and stack building Pioneer Technical Insights 302-304 found at www.pioneer.co.nz

Other resources include:

NZ Weeds in colour - NZ Plant Protection Society

Land Management to Grain Maize - Crop & Food Report 361 - Plant & Food Research

Seed, Rural Supply and Fertiliser Company Booklets

Contractors, Consultants, Seed and Rural Supply reps

12. Glossary

$BW	BW - Breeding Worth. The unit is $. The genetic index given to cows and bulls for their ability to turn feed into profit. BW ranks bulls and cows on their expected ability to breed replacements which will be efficient converters of feed into farmer profit. It is used as a guide to making breeding decisions. Breeding Worth estimates are comparable across herds, ages and breeds. An estimated Breeding Worth of +$100 indicates that using this animal as a parent of a replacement is expected to generate an extra $100 profit per year per 4.5 tonnes of dry matter consumed, compared to using a parent with a BW of zero.
DM	Dry matter.
CRM	Comparative relative maturity, a rating of the maize maturity. High values indicate that the crop will take longer to mature.
GDD	Growing degree days, a term used to describe the accumulated days when the average temperature is over a certain base temperature. For maize, GDD's are calculated using a base temperature of 8°C. $GDD = \frac{(max + min\ temp)}{2} - 8$
K	Potassium, when referring to nutrients.
K	One thousand, when referring to plant population. 89 000 plants per hectare can be describe as 89K/ha.
LWG	Liveweight gain.
ME	Metabolisable energy, a measure of feed value. Reported as megajoules per kilogram of dry matter (MJ/kg DM).
MS	Milksolid.
N	Nitrogen.
P	Phosphorus.
T	Tonnes (1000 kg).

Notes

“Maize is a vital crop for many New Zealand dairy farmers; it also represents a significant investment in time and resources. This booklet aims to give farmers the tools that they need to extract maximum value from this investment, providing the most topical information on maize crop preparation, management and harvest, in one easy to access resource.”

This technical guide is brought to you from:

DairyNZ

Environment Waikato REGIONAL COUNCIL

FAR

PIONEER® BRAND · SEEDS

Plant & Food RESEARCH RANGAHAU AHUMĀRA KAI
