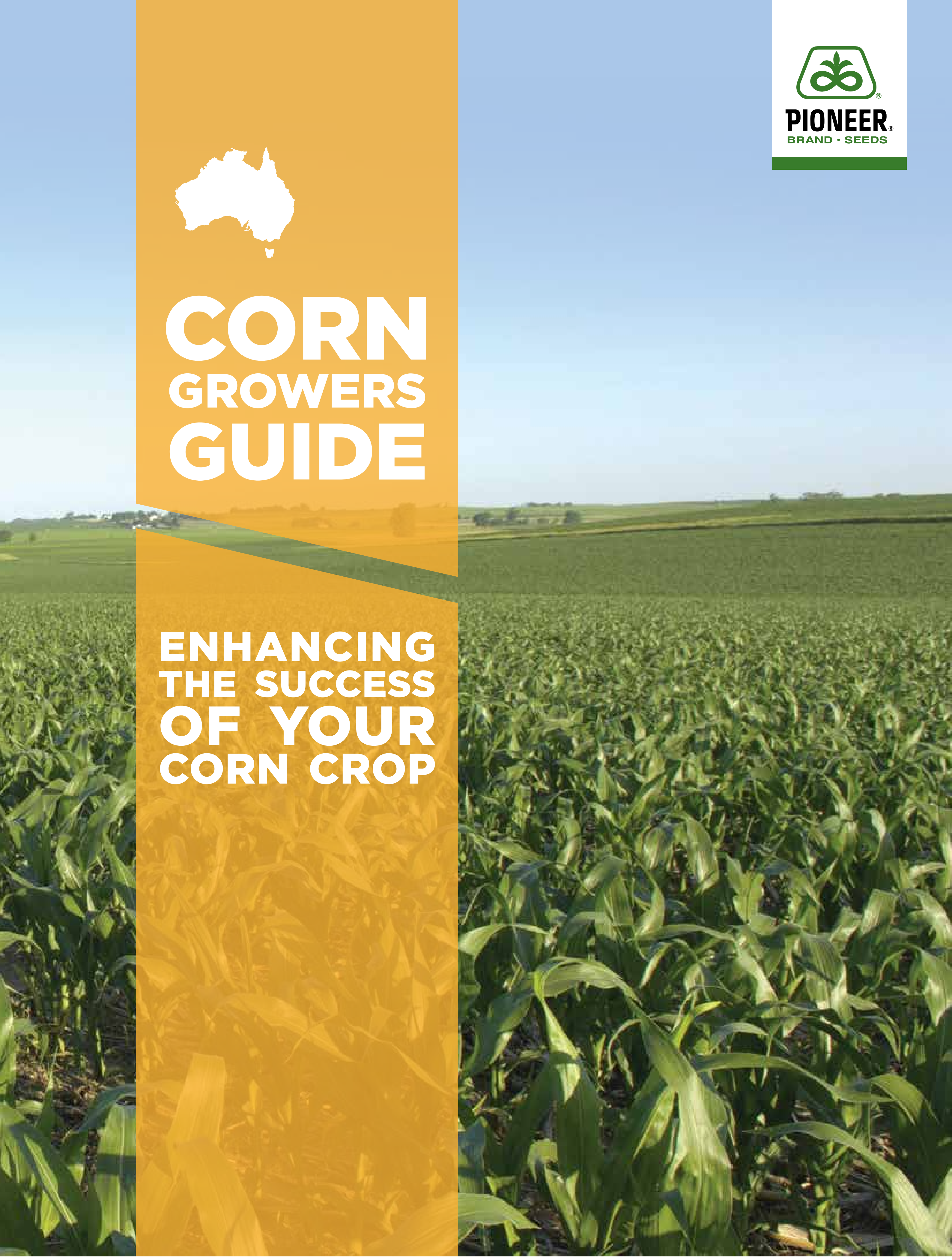

CORN GROWERS GUIDE

ENHANCING THE SUCCESS OF YOUR CORN CROP

TECHNOLOGY THAT **YIELDS**®

PIONEER LONG LOOK

- We strive to produce the best products on the market.
- We deal honestly and fairly with customers, employees and business associates.
- We vigorously market our products, but without misrepresentation.
- We provide helpful management information to assist customers in making optimum profits from our products.

SEED360

SERVICE
QUALITY
STEWARDSHIP

SEED 360 REPRESENTS THE PIONEER TEAM'S COMMITMENT TO ENHANCE THE SUSTAINABILITY AND PROFITABILITY OF AUSTRALIAN FARMERS AND THOSE WHO SERVICE AND SUPPORT THEM.

We are dedicated to providing our customers with high-yielding quality seed and great supply. But it doesn't end there. SEED 360 also focuses on providing valuable advice, tools and stewardship to support your crop from the ground up.

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1 INTRODUCTION

THIS CORN GROWERS' GUIDE AIMS TO PROVIDE INFORMATION ESSENTIAL TO ANY FARMER (INCLUDING THOSE WHO ARE NEW TO CORN) IN UNDERSTANDING SUCCESS AS A CORN GROWER.

Due to rapid advances in plant breeding technology, plant protection and management expertise over the past decade, there have been significant increases in the yield potential and stress tolerance of corn. For many farmers producing corn as a grain crop or for silage production, the potential exists to increase profits. There are many important factors which will contribute to this. For irrigation farmers, we could also add water management.

The yield potential of corn will vary between districts and farms because of water availability, altitude, sunlight, soil structure and soil fertility. Yield potential will also vary between seasons at the same site depending basically on the season (e.g. heat wave, drought) as well as choice of hybrid, sowing time and other associated management decisions (e.g. type and quantity of fertiliser applied and its timing).

However, good management is a key to economic crop production. Good farmers achieve high corn yields by making sure the plant has access to sufficient plant nutrients and in the right proportions during the whole growing season.

A balanced fertility program is therefore a major step towards obtaining higher yields.

Well-fertilised crops can also have other benefits to the growing plant.

Irrigation experiments in the USA have shown that a well fertilised corn crop was 43 percent more efficient in using water than a non-fertilised crop.

IRRIGATION EXPERIMENTS IN THE USA HAVE SHOWN THAT A WELL FERTILISED CORN CROP WAS 43 PERCENT MORE EFFICIENT IN USING WATER THAN A NON-FERTILISED CROP.

2 STRIKE – BREEDING BETTER PRODUCT DECISIONS

PIONEER AUSTRALIA HAS ALWAYS KNOWN THAT LOCAL TESTING IS CRITICAL TO HELPING GROWERS MATCH THE RIGHT PRODUCT TO THE RIGHT ACRE. CONDUCTING STRIKE (SEED TECHNOLOGY RESEARCH IN KEY ENVIRONMENTS) TRIALS LOCALLY WHERE YOU FARM LETS YOU SEE WHICH PRODUCTS OFFER THE BEST PERFORMANCE IN YOUR ENVIRONMENT.

Pioneer Australia has invested $1.2 million in equipment to support the harvesting of STRIKE trials and has employed a full-time team to manage the process.

The objective of STRIKE is to test potential new hybrids over multiple seasons in a range of locations across Australia. Over a minimum of two years we identify hybrids that perform consistently and meet our minimum trait package criteria. Hybrids that successfully perform go on to be advanced and become commercially available for Australian farmers to grow.

The key to STRIKE is testing hybrids on-farm in our customers paddocks, over multiple years, in the same conditions that farmers would experience. The STRIKE program remains an industry leader because of the design of the trials. It's a replicated, randomized trial design with diagonal check hybrids entered throughout the trial, ensuring the data is accurate and not affected by paddock variation, environment or other variables.

MORE THAN JUST YIELD

New hybrids planted in STRIKE trials are carefully observed and their performance is rated for a broad range of plant performance characteristics such as standability, disease resistance, grain quality and yield. Experimental hybrids that offer real advantages over existing commercial products are identified for local seed production and commercialisation.

New hybrids will only be advanced if they exceed the agronomy and disease tolerance requirements for the environment they will be grown in. By the time a hybrid has been commercially released, you can be assured it has been tested over multiple years – usually around 5-6 years, and in multiple locations.

POSITIONING PRODUCTS

Trials conducted by the Pioneer STRIKE team around the country each season help determine which products to advance and provide growers the opportunity to attend field walks to view new hybrids. They also allow our Area Managers and the Promoter team to gain knowledge of the hybrids in your growing region. From all these trials, we understand the true potential of hybrids and where they perform best. This goes a long way in helping farmers select the right product for the right paddock.

CHOOSING WHAT FITS

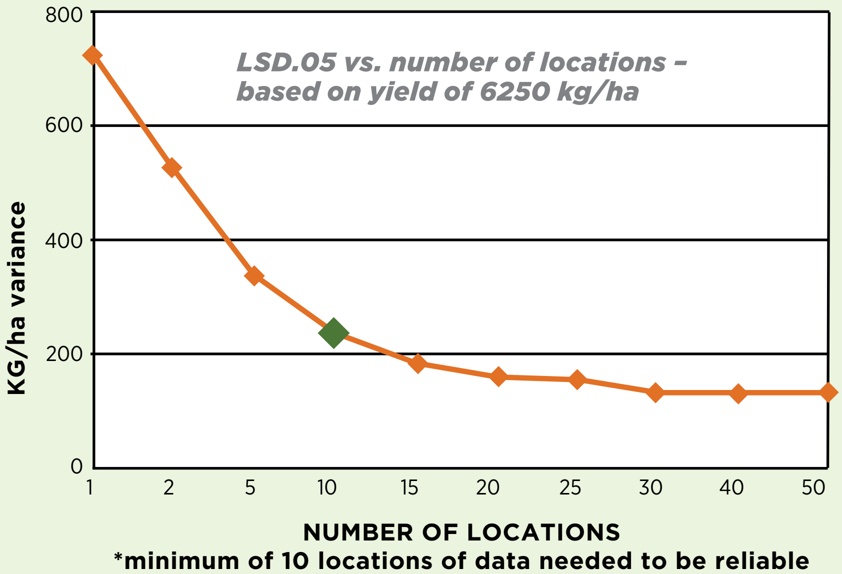
Over the past 40 years, Pioneer research technicians, contractors and local farmers have planted thousands of hybrid plots in trials across Australia. When you see Pioneer® brand hybrids winning in your paddock, it's because they have made it through the most rigorous testing.

LSD – LEAST SIGNIFICANT DIFFERENCE

STRIKE trials

THE BEST SEEDS START WITH THE BEST TRIAL PROGRAM

- Least significant difference (LSD) is used to compare means (averages) of different treatments (in our case hybrids) that have an equal number of replications within a trial or study.
- The LSD formula calculates the amount (in our case kg/ha) of difference between treatments that is required for them to be statistically different within that experiment/trial and not due to chance.
- Due to chance factors include: environmental, soil, mechanical etc. at one site or across sites. A hybrid with a 625 kg yield advantage will win 78% of the time. The other 22% of the time (equivalent to 1 in 4 farmers) is due to conditions usually out of our control and is not representative of the hybrid's future performance. This is why Pioneer research studies/trials are conducted over multiple locations and under different environmental conditions to improve their robustness and ensure the most accurate data is available for product advancement decisions.



- Worldwide researchers have proven that more locations and replications will increase the accuracy of the data collected, as well as reducing the amount of LSD; giving more confidence that differences between treatments/hybrids are real.

LSD.05 VS. NUMBER OF LOCATIONS – BASED ON YIELD OF 6250 KG/HA

As the number of locations increase, the due-to-chance differences between hybrids decrease, highlighting the true overall performance and stability of the hybrid (as per below).

Note: the LSD really begins to level off after 10 locations.

3 WHAT IS A PROFITABLE CROP?

MANY GROWERS ASSUME THAT THE HIGHEST YIELDING CROPS ARE ALSO THE MOST PROFITABLE. THERE IS A FEELING THAT INCREASING INPUTS SUCH AS FERTILISER AND WATER WILL AUTOMATICALLY LEAD TO BIGGER YIELDS, AND HENCE MORE PROFIT PER HECTARE.

Unfortunately, increasing inputs to maximum levels does not always lead to bigger yields and a better profit margin. The highest yielding competition winning crop may attract a lot of interest but it may not be as profitable as a lower yielding crop that is well managed.

The most profitable corn crop is obtained by optimising (rather than maximising) the key inputs such as seed, fertiliser and water, and the timing of these inputs as shown in *Figure 1*.

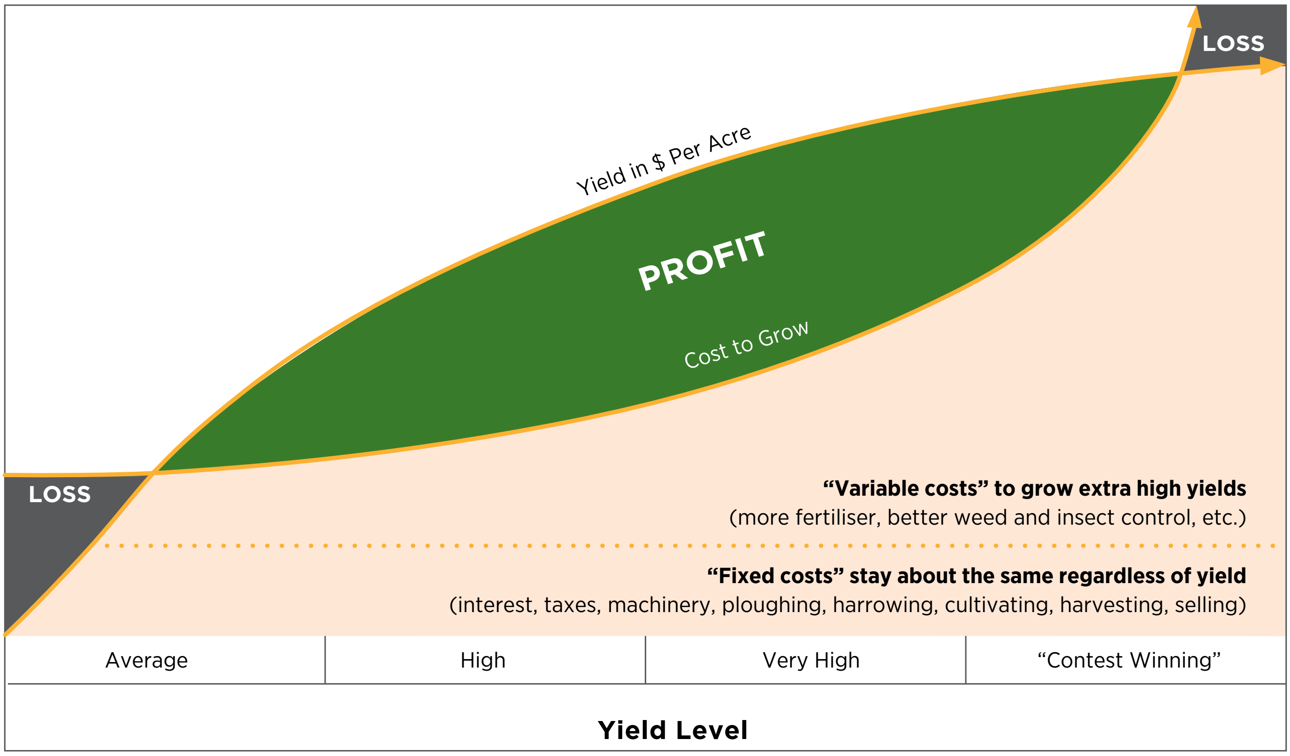
Many farmers underestimate the effect of yield on profit, equating a 10 percent increase in yield with a 10 percent increase in profit. The real increase in profit may be 50 percent or even 100 percent. This is because many costs, such as cultivation, planting, spraying etc. remain the same for all yield levels.

Unless you over-spend on the variable costs such as fertiliser, water, herbicides etc., yield will rise faster then cost giving you both more corn to sell and a greater profit margin per tonne of corn.

The critical factor is to know whether increasing your corn yield (by increasing your inputs) will give an improvement in your profit margin.

The following sections address each of these aspects of growing a profitable corn crop.

Figure 1



IMPORTANT STEPS TOWARDS A PROFITABLE CORN CROP ARE:

- Determining the market you intend to supply
- Understanding the requirements of the crop
- Setting a yield goal for each field
- Planting suitable hybrids at the correct plant populations
- Providing adequate fertiliser and water at the critical growing stages
- Only growing an area you can manage

4 HOW THE CORN PLANT GROWS

A BROAD UNDERSTANDING OF THE GROWTH OF A CORN PLANT WILL ALLOW US TO LOOK AT WHEN THE CRITICAL GROWTH STAGES OCCUR AND THE NUTRITIONAL AND WATER REQUIREMENTS AT THOSE TIMES.

Too often farmers spend a considerable amount of money on fertiliser, cultivation and watering their crop only to end up with an average yield. They have effectively used the optimum level of inputs but have not achieved the optimum high yield – usually because of poor timing of inputs or poor crop management.

This is usually due to a lack of knowledge (or clear understanding) of the growth habits and requirements of a corn crop.

The development of a corn plant and its requirements are shown in *Figure 2* (on page 9).

All corn plants follow the same general pattern of development, but differences in the time various growth stages take depends primarily on the hybrids maturity (given similar conditions). The times, heights and comments indicated in *Figure 2* (on page 9) are for a hybrid with a Comparative Relative Maturity (CRM) of approximately 120 days.

WEEKS 0:

GERMINATION AND SEEDLING ESTABLISHMENT

This is the first critical stage in the life of the corn plant. If the soil is too wet, too cold or too dry, germination may be slow or the young seedling may die before establishment.

As the roots begin to take over the job of nourishing the plant, shortages of major elements can seriously slow growth and development.

However many of the troubles which can occur at this stage (including frost) need not have a permanent effect on growth or yield. The young plant is flexible in its requirements and has a high capacity to recover from early setbacks.

WEEKS 1-3:

VEGETATIVE DEVELOPMENT

This stage creates the root system and leaf structure which will be used later to support the ear and grain formation.

All the leaves the plant will ever have are formed during the first 3 weeks of growth.

They are formed by a single growing point which is actually below the surface of the ground.

If the soil is too wet, too cold or too dry, germination may be slow or the young seedling may die before establishment. Corn plants are susceptible to damage by flooding, especially if temperatures are high.

Although good growth is desirable, this vegetative stage is not as critical in determining yield as earlier or later stages. The corn plant will recover from injury in this stage if later conditions are favourable and use good agronomy practices to assist in that recovery e.g. foliar fertiliser application, inter-row cultivation etc.

WEEKS 4-5:

TASSEL AND EAR INITIATION

Approximately 30 days after planting (when the corn plant is about knee high) a dramatic change takes place in the function of the growing point.

The growing point is at the soil surface, and having formed all the leaves, develops into an embryonic tassel.

WEEKS 5-8:

VEGETATIVE GROWTH

This stage (including the following flowering stage) is the most critical period in the development of the corn plant.

The plant has a high requirement for nutrients, water and the products of metabolism. Any shortages of nutrient, (especially nitrogen) or water, insect damage or overcrowding will have a serious effect on yield.

Any damage to the pollen or ear structures at this time will be permanent and has little chance of being overcome later.

During this stage the lower internodes elongate rapidly, and the plant undergoes extremely rapid vertical growth.

The roots also grow rapidly and soon fill most of the root zone.

Although ears begin to form shortly after tassel initiation, ear size is determined over a three week period in weeks 6-8.

The numbers of rows per ear are determined first, then kernels per row.

Water or nutrient deficiency at this time will greatly reduce grain yield.

WEEKS 9-10:

FLOWERING

Having developed the plant structure, the maize plant then directs most of its energy and nutrient towards producing kernels on an ear. This is a critical growth stage because of the heavy demand for water and nutrient (especially nitrogen) caused by the tremendous physiological activity of the flowering plant. These requirements are complicated by the fact that flowering usually occurs in the middle of summer during hot weather.

A shortage of pollen is rarely a problem and a poor seed set is usually the result of nutrient or water shortages that either delay silking or result in kernels aborting after pollination.

WEEKS 11-18:

GRAIN DEVELOPMENT AND MATURITY

The numbers of ears and kernels have previously been set.

But adverse conditions such as moisture stress will reduce kernel fill.

Exceptionally favourable conditions of moisture and fertility will result in better than usual kernel fill and hence a better grain yield than expected.

This stage chiefly determines kernel size.

Approximately 50-70 days after pollination the corn kernel has reached the greatest dry weight it will have and can be considered physiologically mature.

Physiological maturity can be easily determined by the appearance of a 'black layer' at the tip of the grain.

UNDERSTANDING A CORN PLANT'S DEVELOPMENT AND ITS CRITICAL GROWTH STAGES IS ESSENTIAL IF YOU ARE TO ACHIEVE HIGH YIELDS AND OBTAIN MAXIMUM PROFITABILITY.

This analysis of the development of the corn plant is obviously very brief, however it does highlight the critical growth stages when a shortage of inputs will have serious effects on the final yield of the crop. This information should be used to develop a crop strategy that will yield a good profit margin based on your environment, financial and farm circumstances, and goals.

It should also be used to analyse the levels of, and strategies involved with, three of the key inputs in a successful/ profitable corn crop, namely seed, fertiliser and water.

UNDERSTANDING A CORN PLANT'S DEVELOPMENT AND ITS CRITICAL GROWTH STAGES ARE ESSENTIAL IF YOU ARE TO ACHIEVE HIGH YIELDS AND OBTAIN MAXIMUM PROFITABILITY.

Figure 2: Nutrient requirements

Weekly requirements (as percentage of total need)

MATURITY	%N	%P	%K	% WATER
17 weeks	<1	<1	–K	<1
16 weeks	<1	1	–K	1
15 weeks	<1	2	–K	2
14 weeks	<1	5	–K	3
13 weeks	2	8	–	5
12 weeks	4	19	–	6
11 weeks	6	11	1	8
10 weeks	10	13	5	11
Silking	12	15	8	12
Tasseling	16	11	16	12
7 weeks	15	10	20	11
6 weeks	14	7	21	10
5 weeks	11	4	16	7
4 weeks	7	2	9	5
3 weeks	2	1	3	4
2 weeks	<1	<1	1	2
1 week	<1	<1	<1	1
Emergence	<1	<1	<1	<1

5 NUTRIENT REQUIREMENTS OF CORN

OF ALL THE ESSENTIAL NUTRIENTS DERIVED FROM THE SOIL, N, P AND K (THE PRIMARY NUTRIENTS) REPRESENT 83 PERCENT OF THE TOTAL ABSORBED. CALCIUM (CA), MAGNESIUM (MG) AND SULPHUR (S) ARE THE SECONDARY NUTRIENTS AND REPRESENT ANOTHER 16 PERCENT LEAVING ONLY 1 PERCENT FOR THE MICRONUTRIENTS.

The amounts of the micronutrients (boron, chlorine, copper, iron, manganese, molybdenum and zinc) required are very small but are still important to achieving maximum yield and should only be applied when necessary.

Certain soil conditions are more likely to have problems than others e.g. zinc deficiency on high pH soils. Of the secondary nutrients magnesium and sulphur are the most likely to be a problem, and then most likely only on low pH and/or sandy soils.

Once a yield goal has been set, then a fertiliser program can be worked out to provide the necessary nutrients. The yield goal should be set so that it falls in the upper ranges of what is believed attainable, and then calculate what amounts of fertiliser to apply to reach that goal. *Figure 3* shows the amounts of N, P, K, S and Mg removed by a corn crop depending on yield and whether the crop is for grain alone or for silage. A crop of 5.5t grain/ha (40t green chop/ha) would be a yield that could be obtained under reasonable dry land conditions. A crop of 11t of grain/ha (65t green crop/ha) would be an achievable yield under irrigated cropping conditions.

The Australian record for a corn crop for grain is 21.5 t/ha and the genetic potential is believed to be around 36 t/ha.

5A. THE SOIL – OUR BANK BALANCE

The fertility of a soil is a combination of its physical characteristics (structure, texture, stability, density, organic matter content) and its nutrient status (amount of nitrogen, phosphorus, potassium and other essential nutrients which are readily available to the crop). To grow a profitable crop we should aim for the best combination of both.

The cultural practices employed in the growing of a crop (e.g. no till versus conventional farming) will have the greatest effect on a soil's physical structure. That is beyond the scope of this guide. Suffice to say however, that the greater the volume of soil the root system can explore, the greater the yield potential will be.

Growers with hard setting soils should implement practices such as deep ripping to break hard pans and permanent beds or zero-till to improve moisture infiltration to the root zone of the crop. Inter-row cultivation can also be used to improve crop growth and water infiltration as well as control weeds.

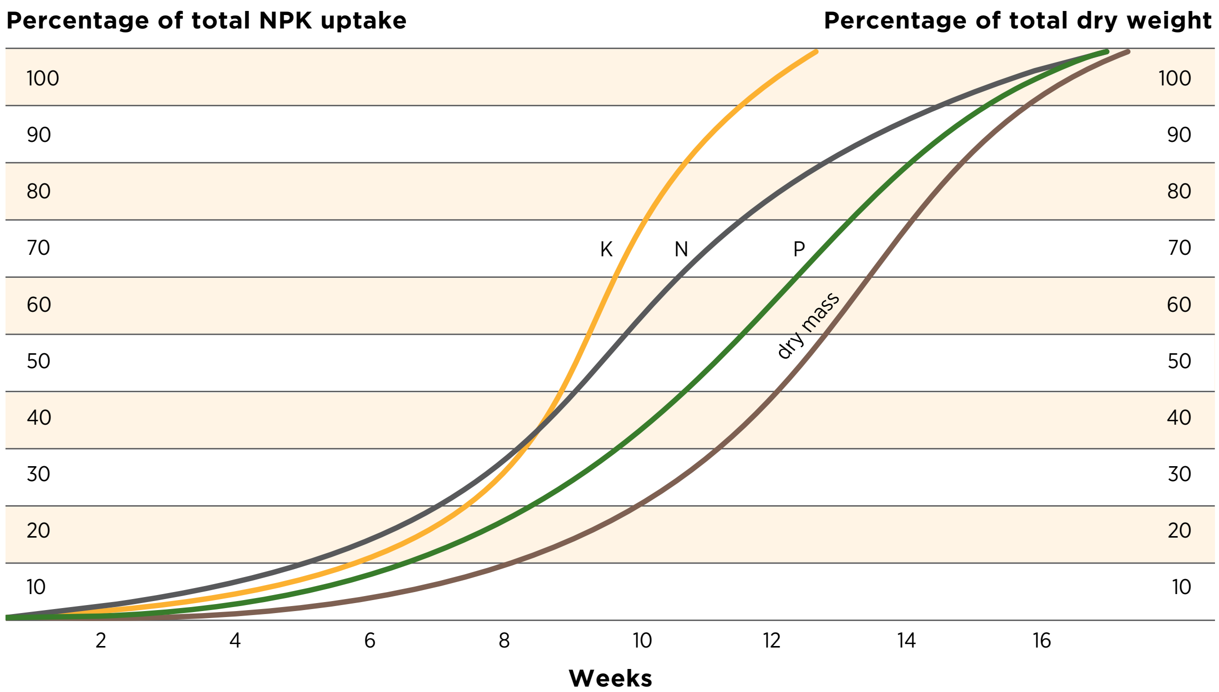
Except for some carbon, hydrogen and oxygen derived from the air, the soil is the sole supplier of the plant's nutrient and water requirements (except where foliar fertilisation is used for a specific purpose).

Figure 3: Plant nutrients taken up by a corn crop

		KILOGRAMS PER HECTARE				
Corn: Grain and Silage		**N**	**P**	**K**	**S**	**Mg**
5.5 t/ha grain	Grain	121	19	24	9	11
40 t/ha green chop	Stover	44	7	97	11	20
(12.8t dm/ha)	**Total**	**165**	**26**	**121**	**20**	**31**
7 t/ha grain	Grain	136	24	30	11	13
50 t/ha green chop	Stover	54	10	120	13	25
(16t dm/ha)	**Total**	**190**	**34**	**150**	**24**	**38**
8.5 t/ha grain	Grain	151	28	36	13	15
58 t/ha green chop	Stover	64	12	143	15	30
(18.5t dm/ha)	**Total**	**215**	**40**	**179**	**28**	**45**
10 t/ha grain	Grain	176	32	41	15	17
65 t/ha green chop	Stover	74	14	167	17	35
(20.8t dm/ha)	**Total**	**240**	**46**	**208**	**32**	**52**
11 t/ha grain	Grain	190	35	45	16	18
70 t/ha green chop	Stover	80	15	180	18	35
(22.4t dm/ha)	**Total**	**270**	**50**	**225**	**34**	**56**

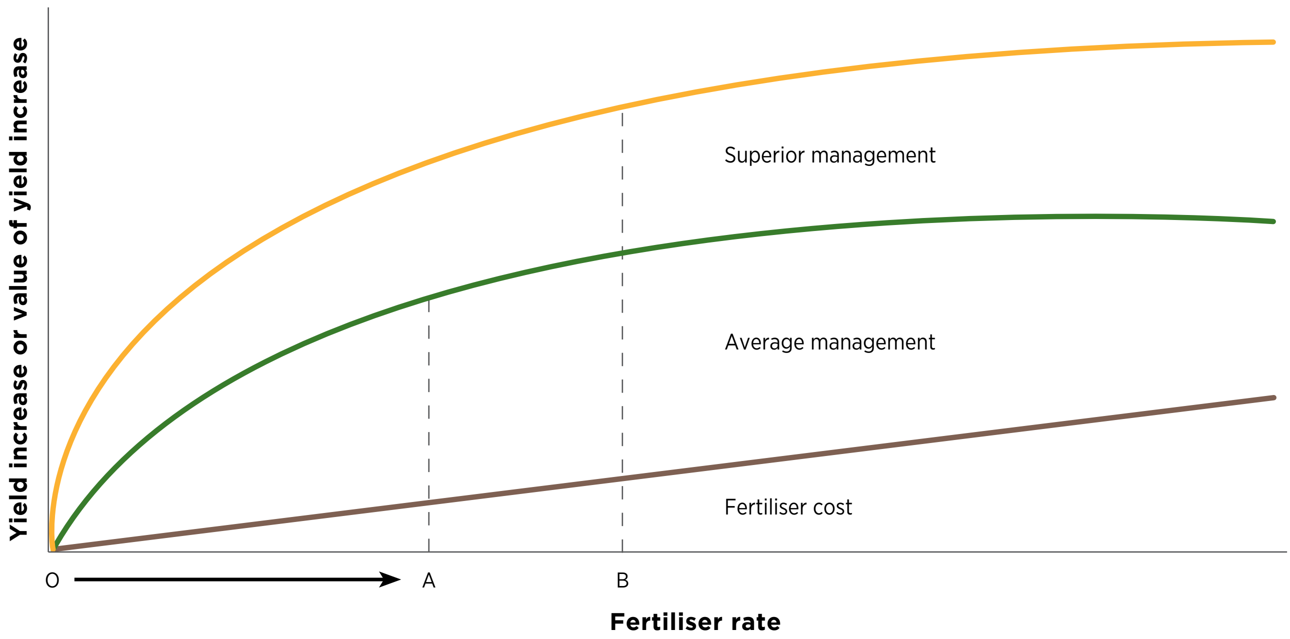
It should be noted that these figures are not absolute values. There can be variations up to 10 percent depending on conditions. Of special note is that silage removes more nutrients than grain alone, especially potassium.

Figure 4: The periods and rates of uptake for N, P and K by a corn crop



While Figure 3 shows the total quantity of major nutrients required, the above Figure 4 indicates the periods and rates of uptake for N, P and K. By using the two tables in conjunction a calculation of the fertiliser quantities required by the corn crop at each stage of growth can be determined.

Figure 5



With superior management, higher rates or fertiliser can be profitably used than with average management. With average management rate A is optimal, with superior management rate B is optimal. (From Strizel, 1963).

The soil holds plant nutrients in many forms. Some are readily available to the plant while others have to be changed from an inorganic form to an organic form the plant can use. It is important to note that while the crop nutrient requirements are minimal in the first 6 weeks of growth, the majority of fertiliser should be applied at or prior to planting.

Different soil types hold different amounts of nutrients and water for the plant to use. Sandy soils are usually low in fertility (low organic matter and leach readily) and need small doses of fertiliser and water often (unfortunately this is not always practicable). Clay soils on the other hand are inherently more fertile and hold more water due to the higher level of organic matter in the profile and their greater cation exchange capacity (a result of their clay content).

Not all soils have nutrients in a form available to the plant – some soils have a high fixing capacity (e.g. phosphorus in highly calcareous soils or high pH soils).

The nutrients in the soil can be likened to a savings account. The amount of nutrient available to the plant is like the interest available from a savings account. The larger the nutrient level in the soil (savings account) the larger the amount available to the plant (interest).

Another influence on the availability of nutrients is the soil's pH. *Figure 6* shows the changes in plant nutrient availability with changes in the soil pH. The width of the horizontal bar indicates the relative availability of each nutrient. Optimum pH for corn is between pH 6.0 and pH 7.0. Lime will make soils more alkaline and increase the availability of some nutrients when applied to acid soils.

The results of these tests cannot tell precisely how much fertiliser is required to be applied. They do give an indication of the nutrient levels present and whether the levels are high, medium or low. From this, and experience, an indication of how much fertiliser to apply can be determined.

If the soil is sampled every year or two, the soil's nutrient status and pH can be monitored and an assessment made about whether the levels are rising, falling, or being maintained. The effectiveness of the fertiliser programs can then be assessed by analysing crop yields and the residual effect on soil fertility.

Plant tissue testing is probably a more reliable indicator of the plants need for micronutrients (or trace elements). While this analysis often comes too late to prevent deficiencies, it can be useful for overcoming deficiencies and modifying the fertiliser programs for following crops.

SOIL TESTING AND PLANT TISSUE ANALYSIS ARE USEFUL TOOLS TO HELP WITH FERTILISER DECISION MAKING.

This introduces the concept of maintenance fertilisation. This concept aims to keep the soil at a constant level of fertility by replacing what has been taken out by each crop. In practice however, this applies mainly to the major nutrients of nitrogen, phosphorus and potassium. A deficiency of a micro nutrient can have just as damaging effect on yield as a macro nutrient even though they are only required in small quantities (e.g. zinc).

If a soil's fertility has been allowed to run down it may take several years of high applications of fertiliser (at high cost) to overcome the soil fixing capacity and rebuild the fertility to its original level. Maintenance fertilisation helps to overcome this problem and keep the soil's fertility at a stable level.

5B. NITROGEN (N)

Nitrogen is an essential factor required for producing good yields.

Rates of applied N are very much dependent on the yield potential of a particular soil situation.

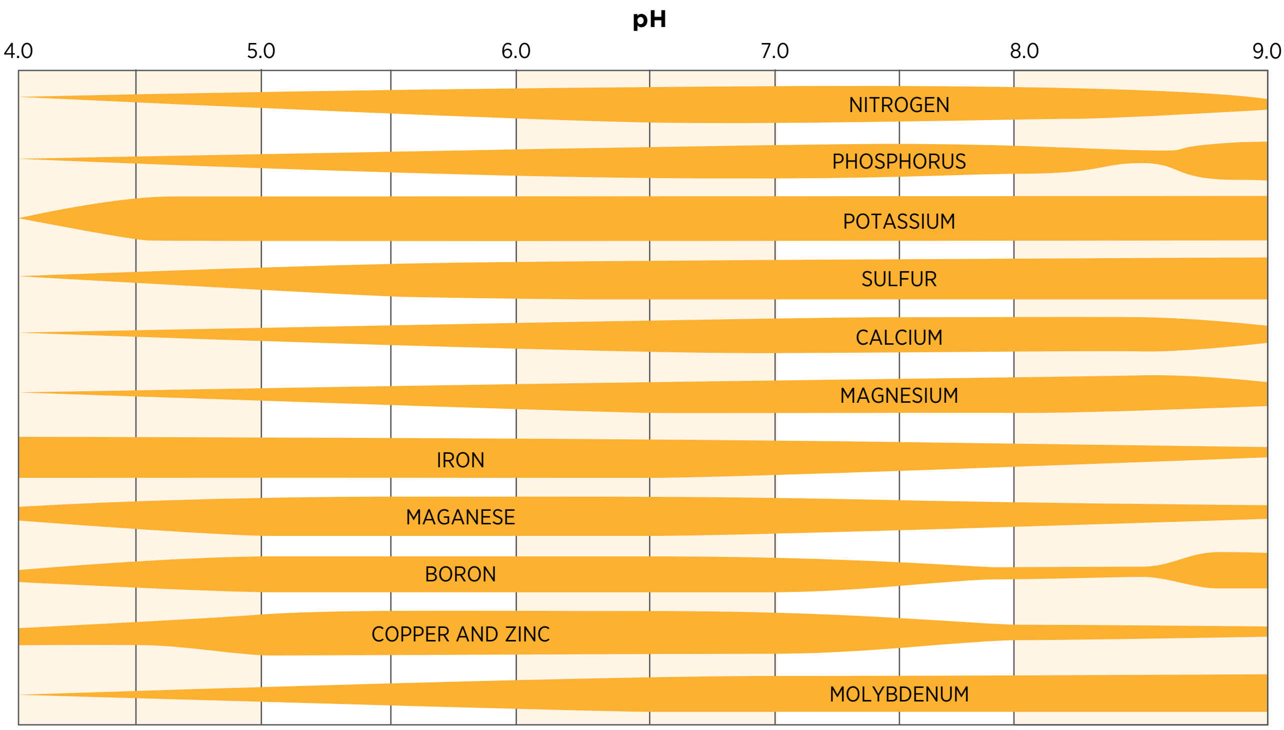
A soil test can give a useful guide to available nitrogen for the crop. The nitrogen fertiliser then needed may be pre-applied and/or applied at planting, with side-dressing to fill the total requirements.

Post-emergence applications are useful for irrigated crops or where heavy rain falls after emergence. If the total amount of fertiliser to be applied is side-dressed and application is delayed beyond the first four weeks after sowing, some yield potential may be lost. (Refer to *Figure 2 page 9*.)

Nitrogen is very mobile in the soil and losses through leaching can be substantial. Denitrification losses can also be substantial in wet soils. The techniques of split nitrogen application and/or water run nitrogen can be used to great advantage under these conditions.

There are two other points to consider when determining nitrogen application rates. Firstly the efficiency of uptake of fertiliser-N is often only of the order of 50 percent. Secondly organic (soil) N is approximately 15-20 percent more effective than applied fertiliser N for crop growth. This latter point has important management implications with regards to crop rotations and residual N in the soil.

Figure 6: Variability of plant nutrients to soil pH



Available nutrients in relation to pH.

IN SOME SOILS, PHOSPHORUS CAN REACT WITH OTHER SOIL COMPONENTS AND BECOME UNAVAILABLE TO PLANTS.

An 11 t/ha grain chop (70 t/ha green chop) will only take up 35 percent – 95 kg – of its total nitrogen requirement during the first six weeks after emergence. Then the next four weeks (prior to and during silking) will see 53 percent of the total N requirements (145 kg) taken up.

Uptake peaks at 4 kg of N/ha/day, placing huge demands on fertiliser availability and grower management.

Nitrogen deficiencies show in several ways. When young corn is short of nitrogen, the whole plant is pale yellowish green, small, and has spindly stalks. Later, beginning with the bottom leaves, the typical V-shaped yellowing from the tips of the leaves shows. The greater the deficiency the greater the number of bottom leaves affected. Small cobs, often with bare tips, result when nitrogen deficiencies occur during silking and grain fill. Refer symptom pages (see page 51).

5C. PHOSPHOROUS (P)

Soil analysis results are useful when developing a phosphorus fertiliser program. In some soils, phosphorus can react with other soil components and become unavailable to plants. In these soils, when applying the P fertiliser, band application is generally the preferred method (5 cm below and to the side of the seed). This reduces the P fixation and improves the recovery efficiency of the P fertiliser. Recovery is typically seldom more than 15-20 percent of that applied, even under good conditions.

P is vital in early root and seedling development. For normal growth the young plants need a higher percentage of P in their tissues than they will later in the season. Also, P is not mobile (the opposite of N) and does not leach out of soils. This allows all the P to be applied prior to or at planting so that the roots may have access to the fertiliser.

Further, P uptake in plants can be restricted by poor root establishment (e.g. compaction, planting slot smearing) and cold wet conditions, which may occur with early plantings and can result in poor root vigour. Starter fertiliser will help in these situations.

If P deficiency is going to show it will appear before the plants are 65 cm tall. It is characterised by slow stunted growth, plants that are very dark green with reddish purple leaf tips and margins and stems that can show a purple colouration. As the plant develops, plant maturity will be delayed and silks emerge slowly.

An 11t/ha grain crop (70 t/ha green chop) takes up about 30 percent – 15 kg – of its P requirements during the first 55 days. Peak uptake of 0.75 kg/Ha/day occurs during the 7-10 week period after emergence, with total uptake being about 50 kg. Refer symptom pages (see page 51).

5D. POTASSIUM (K)

Corn requires large amounts of potassium in quantities similar (numerically) to that of nitrogen.

Potassium is essential for vigorous growth, yet never becomes a part of proteins and other organic compounds. It is vital to the structure and efficiency of the functioning of the com plant for the production and movement of sugars to the developing ears.

K does not leach to the same extent as N nor become tied up in unavailable or slowly available forms to the degree that P does. However, like P, it should not be in the surface layer which will regularly dry out and be unavailable to the growing plant.

IT IS VITAL TO THE STRUCTURE AND EFFICIENCY OF THE FUNCTIONING OF THE COM PLANT FOR THE PRODUCTION AND MOVEMENT OF SUGARS TO THE DEVELOPING EARS.

K applications can be carried out at anytime during land preparation. Some forms of K fertilisers need to be applied well in advance of planting to be available to the growing crop.

An 11 t/ha grain crop (70 t/ha green chop) takes up over 50 percent – 117 kg – of its K requirement of 225 kg in the first 55 days. The young seedling does not require much K but the rate of uptake climbs rapidly to a peak in the three weeks leading to tasselling. K uptake peaks at around 4 kg/ha/day during this period and by silking 75 percent of the total K has been taken up.

A deficiency of K shows as yellowing and dying of leaf margins beginning at the tips of the lower leaves. Symptoms appearing at an early stage mean that the total soil supply is low or that the root system is severely restricted – e.g. a compacted soil layer. Refer symptom pages (see page 51).

5E. SECONDARY AND MICRONUTRIENTS

Zinc (Zn)

Corn plants are rated as having moderate to high susceptibility to Zn deficiency.

Zn is necessary early in the plant's growth during the first three weeks. Responses to applied N and P may be affected if the level of available Zn is low. Soils with a high pH (over 7.0), eroded soils, or land formed soils, are most at risk of Zn deficiency. As with other nutrients, yield losses can occur before visible symptoms occur. Typical symptoms are light parallel striping followed by a broad whitish band starting slightly in from the leaf edge and extending to the midrib. The leaf edges, midrib and tip of the leaf remain green.

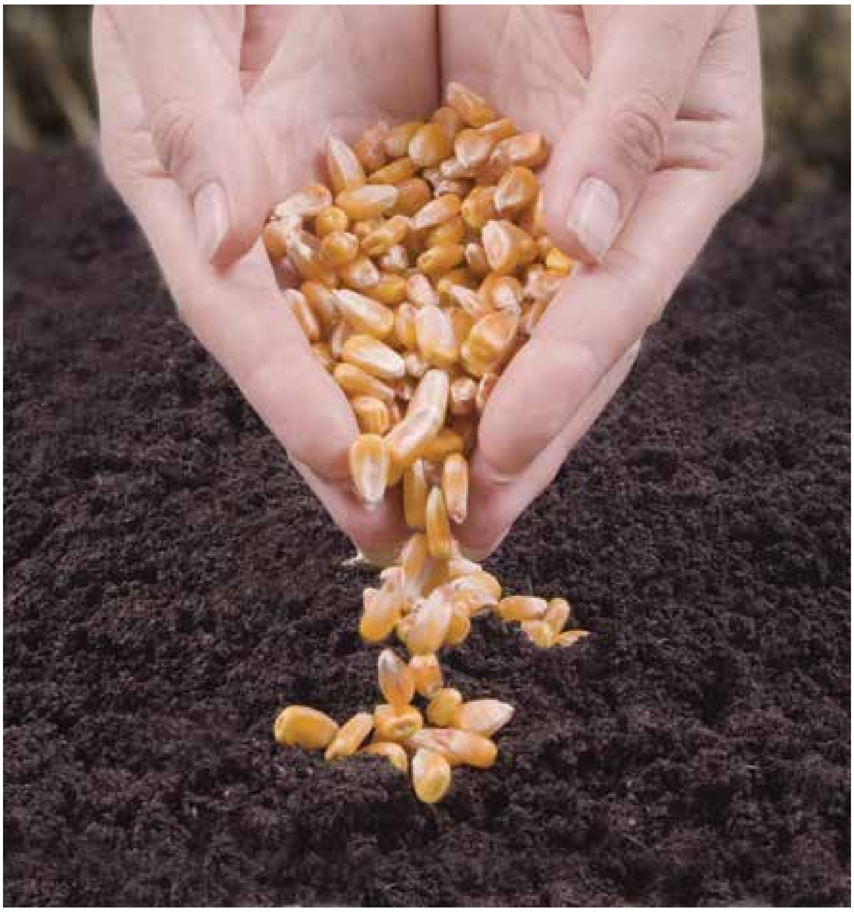
Soil applications of Zn are expected to last several years with rates of 10-20 kg Zn/ha effective for four to five years. Depending on the form of Zn used, applications may need to be made well in advance of the crop.

Foliar applications during water logging periods early in the crop's development can be a useful management tool in helping the crop overcome associated stress.

Water injection and/or foliar (1 percent solution) applications of Zn generally use zinc sulphate heptahydrate or chelated zinc to overcome Zn deficiencies. Foliar applications generally need two sprays about 7-10 days apart, 2-3 weeks after emergence. Refer symptom pages (see page 51).

Sulfur (S) and magnesium (Mg)

Sulphur originates from organic matter and is normally very mobile in the soil. Typical deficiency symptoms of interveinal chlorosis and stunting are usually most severe in the seedling stage. Using a starter fertiliser containing sulphur should correct any problems.



Magnesium deficiency is usually associated with strongly acid sandy soils in moderate to heavy rainfall areas where the Mg can be leached from the soil.

Characteristic symptoms are yellow streaking of the lower leaves between the veins sometimes followed by dead round spots. The older leaves can become reddish purple. Broadcast applications of dolomite should be the most economical long-term treatment. Magnesium sulphate (Epsom salts) is used if a foliar spray is needed. Refer symptom pages (see page 51).

Other nutrients

It is unlikely any other nutrient deficiencies are likely to occur except under very special conditions or circumstances.

5F. MANURE

Manure contains valuable nutrients and organic matter. The composition will vary with both the animal and the feeding regime. Micronutrient deficiencies are seldom found on fields that regularly receive applications of manure.

The nutrients contained in manure are not as efficient as chemical fertilisers in stimulating plant growth in the short term, but there is a residual effect which could last up to four years. This is due to the slow release of the nutrients.

As well as having a value in terms of nutrients, manure also acts as a soil improver.

Organic matter improves soil structure, helps root penetration and reduces the degree of soil compaction, allowing soils to hold more available water.

AS WITH OTHER NUTRIENTS, YIELD LOSSES CAN OCCUR BEFORE VISIBLE SYMPTOMS OCCUR.

Some figures from a Dalby feedlot showed the feedlot manure contained 2.17 percent N, 1.28 percent P and 2.61 percent K. Therefore one tonne of manure (dry matter) would contain 21.7 kg N; 12.8 kg P and 26.1 kg K but only a percentage of this is available in the first year (possibly 35 percent of the N, 60 percent of the P and 90 percent of the K) the rest becoming available in subsequent years. Variations in soil types, climatic conditions and manure used will greatly affect the immediate availability of these nutrients.

Therefore, as N is a critical nutrient for producing maximum yields, it would be recommended that the amount of N from manure is not calculated in the first growing year of application.

When considering using manure, have an analysis done, so that a cost can be put on the nutrients it contains. It can be more difficult to put a cost on the soil improving qualities of manure. Each situation must be taken on its own merits but the usage of manure has many and lasting benefits.

The theory of maintenance fertilisation has a lot of merit. Look upon the soil as a nutrient bank. The healthier it is, the healthier the crop will be and the higher the yields will be.

The likelihood of a response to fertiliser is reduced by any factor that reduces crop growth. Yield increases from the use of fertilisers depends primarily on:

- the potential yield
- the levels of soil nutrient
- soil moisture at planting
- the ability of the plant to take up nutrients
- and the availability of plant nutrients and soil moisture throughout the growth of the crop.

Consideration should be given to crop rotations that influence, amongst other factors, the amount of available soil nitrogen for succeeding crops. Soil nitrogen is more effective than fertiliser nitrogen for crop growth. Nitrogen will generally be (in dollars) the single most expensive fertiliser input in the production of a corn crop.

And finally just as good management is a key to economic crop production, good management is definitely a key to economic fertiliser usage.

ORGANIC MATTER IMPROVES SOIL STRUCTURE, HELPS ROOT PENETRATION AND REDUCES THE DEGREE OF SOIL COMPACTION, ALLOWING SOILS TO HOLD MORE AVAILABLE WATER.

6 WATER MANAGEMENT OF CORN

SEED DECAY AND SEEDLING BLIGHTS OF CORN

WHAT DAMAGE IS CAUSED BY COLD, WET WEATHER AND WATERING UP?

In some years, spring stand establishment problems can be severe due to saturated soils, cold soil temperatures, frost injury, herbicide injury, nitrogen deficiencies, seed decay and seedling blights. In some instances seed decay and seedling blight may progress into crown decay resulting in even more severe stunting and yellowing of plants.

Conditions which delay seedling development and emergence give seed decay and seedling blight fungi more of an opportunity to attack developing corn seedlings. Seed decay and seedling blights of corn are generally caused by soil-inhabiting fungi species such as Pythium, Fusarium, Diplodia, Rhizoctonia and Penicillium. These fungi may rot the seed prior to germination or cause pre-emergence or post-emergence seedling blight.

Affected seeds are usually discoloured and soft and may be overgrown with fungi. Rotted seed may be difficult to find because they decompose very rapidly and soil adheres fairly tightly to the decomposing seed. With pre-emergence seedling blights, the seed germinates but the seedlings are killed before they emerge from the soil. The coleoptile and primary roots are usually discoloured and have a wet, rotted appearance.

Most of the fungi which cause seed decay and seedling blight of corn may also contribute to decay of the permanent root system and crown rot of young plants. Tips of the permanent root system may be water soaked and discoloured with the outer layers sloughing off.

The *Pythium, Fusarium, Diplodia, Rhizoctonia* and *Penicillium* species are the primary cause of seed decay, seedling blight and crown decay. If conditions are favourable for germination and emergence, these fungi may not have the opportunity to invade seed, germinating seed or young seedlings so seed decay, seedling blights and crown rot will not be significant problems.

On the other hand, conditions that are not favourable for germination and emergence, give these soil fungi more time to attack the seed and developing plants. Numerous other factors also contribute to early season corn establishment problems. Insect damage, nutrient imbalances, herbicide injury, soil conditions and environmental factors, especially saturated soil conditions and oxygen deprivation, may also cause or contribute to early season corn establishment problems.

Corn seedling blights are more severe in wet soils, from post plant irrigation or in soils that have been compacted or remain wet for an extended period of time. If soil temperatures are below 12°C the wet soil conditions favour Pythium seed decay and seedling blight.

Disease severity is also affected by planting depth, soil type, seed quality, mechanical injury to seed, soil crusting, herbicide injury or other factors which delay germination and emergence of corn. Planting high quality seed into a good seedbed when soil temperatures are above 12°C and rising will help minimise the potential for early season problems.

Virtually all field corn seed comes with a fungicide seed treatment. When evaluating corn stands this season, it is important to check several plants to determine the extent of damage to the initial root systems, the mesocotyls and the permanent root systems.

WHEN IS WATER NEEDED?

The corn plant's development must not be restricted at any stage of growth if maximum yields are to be achieved. The relationship between a crop's growth and water need can best be shown by drawing the water requirement curve over the weight gain curve. This is done in *Figure 7* and it is obvious that the water need increases rapidly from about two weeks prior to tassel and ear appearance until about two weeks after full silk and then decreases rapidly.

It should be noted that *Figure 7* only compares water need and dry weight accumulation on a days after emergence basis.

The fact that there is no scale on the vertical axis means that there is no comparison between the amount of water and the weight of the plant.

An alternative way of indicating water requirement was shown in *Figure 2* (refer previous section – how the corn plant develops).

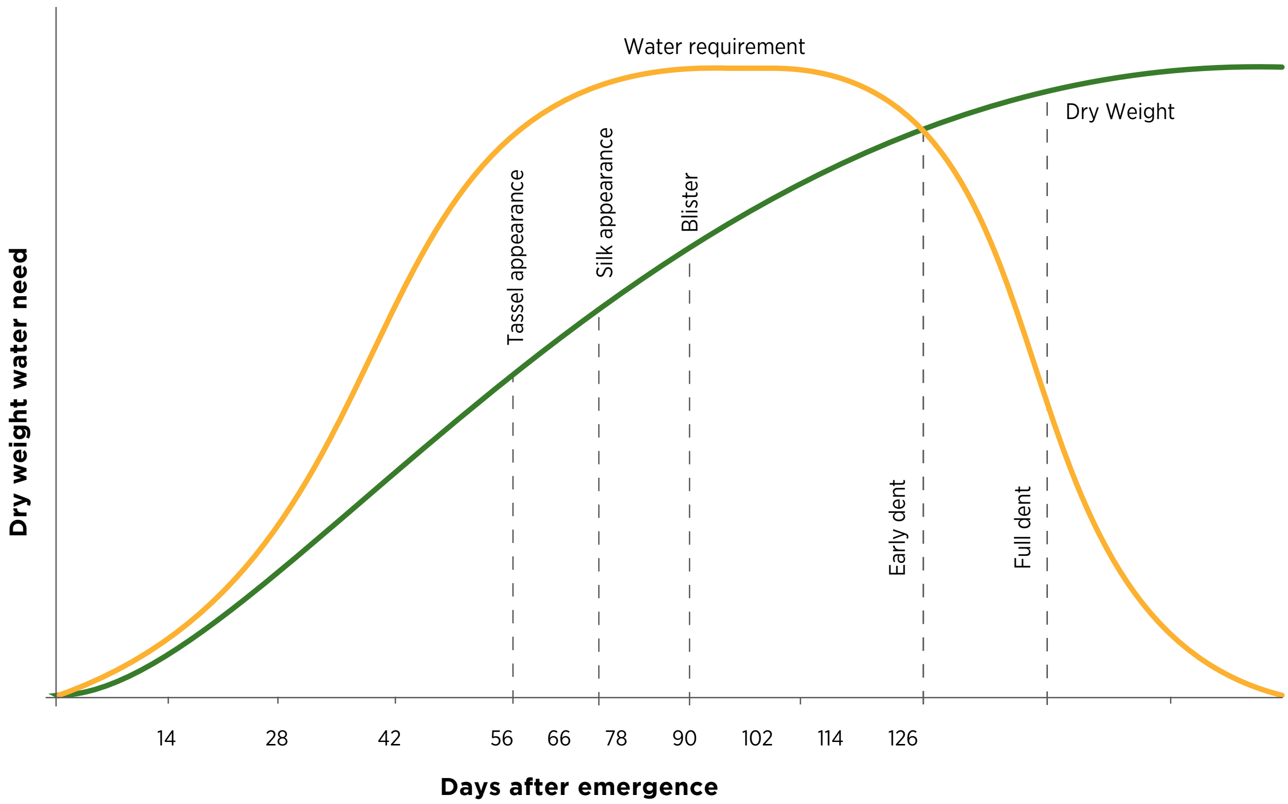
This indicated water requirements each week as a percentage of total water needs, i.e.

- 20 percent in the first five weeks after emergence
- 33 percent in the next three weeks (the three weeks prior to silking)
- 31 percent during the next three weeks during silking and early grainfill

If an irrigated crop of corn in southern Australia uses nine megalitres of water per hectare in a normal season, up to six megalitres are required (and need to be applied) during the six week period from prior to tasselling to early grain fill.

The water available each day, or the rate at which that water can be applied to the crop, becomes very important if timeliness of irrigation is to match the crop requirements and not limit yield.

Figure 7: Water requirements of corn (dry weight gain)



HOW MUCH WATER IS REQUIRED?

Contrary to what is often said, corn is a relatively efficient user of water in terms of dry weight produced for water used. Corn requires approximately 370 kg of water to produce 1 kg of dry weight, compared with approximately 270 for sorghum, 500 for wheat, 560 for cotton, 630 for oats and 860 for lucerne.

However, because there is a lot of weight in a crop of corn, it has a high total water requirement.

If the selection of variety and plant population is adjusted to suit the total amount of water available, and if the water could be metered out in proportion to when it is most needed by the crop, we would have a water: grain yield relationship similar to that shown in *Figure 8*. Obviously a number of factors such as heat, humidity, wind etc., can influence the shape of this curve, but it is a useful guide on which to base yield goals in relation to the amount of water available.

Figure 8 shows that the efficiency of water use increased rapidly as more water was applied (provided population keeps pace) until the hybrid reaches its yield limit.

The soil's capacity to store moisture is a most important factor as it largely determines the amount and frequency of irrigations and is of paramount importance in deciding yield goals under dryland farming. *Figure 9* gives the average water storage capacity of various soil types. Work on corn utilising 1.5 m of soil moisture if there are no physical restrictions.

A silty-clay soil wet to 1.5 m holds 325 mm of water. If 250 mm of irrigation can be applied, or if a total of 250 mm of rain can be guaranteed at the right time, a yield goal of seven tonne per hectare could be set. (*Figure 9*).

GETTING THE MAXIMUM EFFICIENCY OUT OF WATER

Research clearly shows that the total amount of water used by high yielding crops is only slightly more than that used to produce low yields. Factors that affect this efficiency are:

6A. WEED CONTROL

(refer weed control section)

6B. FERTILISER

The old fallacy that fertiliser promotes poor water use is still often heard. To quote one study, yields from 33 irrigation experiments in Nebraska showed than well-fertilised corn averaged approximately 2.5 t/ha more corn than poorly fertilised corn and only used 25 mm extra of water. The well-fertilised corn was 43 percent more efficient in using water. Surprising as it seems, research proves that the total amount of water used by high yielding corn crops is only slightly more than that used to produce low yields. In other words when you improve your crop management in any way – weed control, hybrid selection, plant population – you grow more corn with a given amount of water.

6C. PLANT POPULATION

Contrary to popular belief, the need for water does not go up directly with increasing plant population. More plants do need a bit more water but they also shade the soil and therefore reduce evaporation and also shade themselves and therefore reduce transpiration (losses from leaves).

CORN IS A RELATIVELY EFFICIENT USER OF WATER IN TERMS OF DRY WEIGHT PRODUCED FOR WATER USED.

Figure 8: The relationship between water availability and grain yield

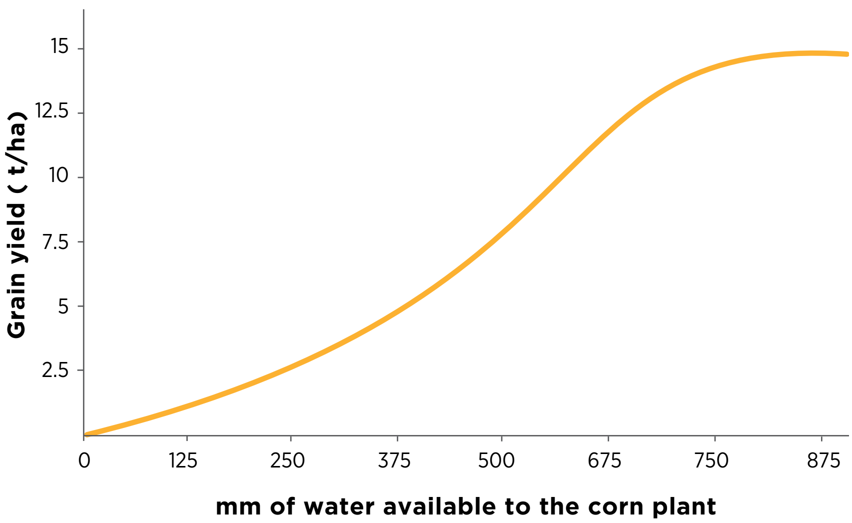


Figure 8 showed that yield increased at a faster rate than the extra water needed. However, these higher yields are dependent on higher plant populations and it follows therefore that higher plant populations are more efficient users of water. This aspect is discussed in the section on plant population.

TRANSPIRATION IS THE PROCESS OF WATER MOVEMENT THROUGH A PLANT AND ITS EVAPORATION FROM AERIAL PARTS, SUCH AS LEAVES, STEMS AND FLOWERS. WATER IS NECESSARY FOR PLANTS BUT ONLY A SMALL AMOUNT OF WATER TAKEN UP BY THE ROOTS IS USED FOR GROWTH AND METABOLISM. THE REMAINING 97–99.5% IS LOST BY TRANSPIRATION.

WHEN CORN PLANTS BECOME STRESSED, THE LOWER PARTS OF THE PLANT WILT AND SUFFER DAMAGE PROPORTIONATELY MORE THAN THE UPPER PARTS.

6D. HYBRIDS

The Pioneer corn breeding program has placed heavy emphasis on developing hybrid's that will yield well in spite of considerable moisture stress. Understanding hybrids ability to handle moisture stress is very important as this can also determine plant populations for different hybrids.

MAKING THE BEST USE OF LIMITED WATER

So far discussion has centred on the corn plant's growth and yield under conditions where water is not limiting. With supplementary irrigation, it is essential to understand the effect of moisture stress at various stages of growth.

It is generally considered that yield is lost when corn is visibly wilted for four consecutive days.

When corn plants become stressed, the lower parts of the plant wilt and suffer damage proportionately more than the upper parts. With some hybrids, this has the serious effect of slowing the development of the silks much more than the tassel. This results in the pollen being finished before the silks emerge and little or no grain is formed on the cobs. Hybrid selection is therefore more important in dryland or limited irrigation situations.

Figure 9: Typical soil water storage capacity of various soil types:

Available water (mm/metre) for each soil type

40 mm/metre Coarse sand	**100** mm/metre Fine sand	**160** mm/metre Fine sandy-loam
175 mm/metre Silty-loam	**215** mm/metre Silty-clay	**230** mm/metre Clay

7 WEED CONTROL IN CORN CROPS

GOOD WEED CONTROL IS VERY IMPORTANT FOR HIGH YIELDS IN CORN, AS IT IS WITH OTHER SUMMER CROPS. WEEDS COMPETE VERY STRONGLY FOR MOISTURE, NUTRIENTS AND LIGHT.

Grass weeds are the most competitive and must be eliminated early. However, broadleaf weeds will also compete strongly with corn. Corn is quite sensitive to weed competition in the early stages of growth up until it reaches about 0.8 m in height.

As well as a detrimental effect on your corn crop yield, weeds can create problems at harvest time by blocking harvesting fronts and sieves, or by causing dockage in payments when the grain is delivered. In severe cases they can cause the grain to be rejected for receival by the customer.

Weed control can be carried out by either mechanical or chemical means, or the combination of both.

MECHANICAL WEED CONTROL

Corn is usually planted in rows up to one metre apart and therefore inter-row cultivation can be practised. Inter-row cultivation can be done up until the corn crop reaches about 0.75 m in height. After that the crop canopy closes over and the corn competes well with weeds.

Inter-row cultivation must be shallow to prevent root pruning of the crop. Wet conditions may prevent cultivation at critical times and/or cause transplanting of weeds.

MECHANICAL AND CHEMICAL WEED CONTROL

Band spraying of chemicals in the crop row combined with inter-row cultivation is a widely-used practice in all types of summer crops.

CHEMICAL WEED CONTROL

There are a number of chemicals available which will give very good weed control through the life of the corn crop if used correctly (always read the label before starting to spray).

8 INSECT PESTS OF CORN

CORN CROPS ARE MOST SUSCEPTIBLE TO SERIOUS DAMAGE FROM INSECTS DURING ESTABLISHMENT (SOIL INSECTS CAN BE SO DESTRUCTIVE THAT RESOWING IS NECESSARY) AND FROM TASSELLING, SILKING UNTIL HARVEST.

With the wider use of conservation tillage and stubble mulching, many farmers have noted an increase in insect activity, particularly in the seedling stages. This observation in no way condemns stubble mulching or associated practices, considering the benefits gained in moisture and soil savings, but highlights that these systems are not without pitfalls. Double cropping also has been responsible for building up populations of soil dwellers such as African black beetle, false wire worm and earwigs.

Together with all other good management inputs, a priority requirement is establishing a plant stand to make full use of the fertility and moisture when aiming for the best possible yield goal.

Knowing if insects are prevalent is the first management step – don't be caught unawares on any soil type. There are many cases of damage occurring on soils where soil insects have never been known in numbers before. A corn crops main soil dwelling insect enemies appear with rises of temperature heralding the summer season.

In areas that frost frequently, pest populations will be slower to build up, as pupae well down in the ground will be the only survivors from the previous summer.

In the northern cropping areas, populations can survive the winter by feeding on crop, crop residue and weeds, though their activity is toned down with the lower temperatures.

From spring, pest activity increases, reaching peak problem proportions with the higher temperatures and humidity of the main planting time. The higher temperatures speed up insect life cycles and, linked with more food availability, all months from September until late February are in the danger period. So, if planting where damage has been suspected in previous years, be prepared to take some precautions.

A thorough check at all periods from ground preparation until harvest enables profit-conscious growers to monitor crop health by simply inspecting their fields.

THE IMPORTANCE OF SEED TREATMENTS

Pioneer recommends Betta Strike® seed treatment to enhance the genetic potential of the corn seed sown. Inadequate protection of the emerging seedling leaves the plant exposed to pests and diseases. In fact many symptoms caused by soil borne insects may not be seen visually until much later in the crop development causing significant potential yield loss.

It is important that the application of seed treatments is professionally applied. Research has show that improper application of seed treatments can significantly reduce the effectiveness of the chemical applied.

This will result in poor protection against insect pests and, in extreme circumstances can cause unnecessary stress on seedling vigour.

In recent years, there is evidence to show that some insect seed treatments can improve early plant growth and vigour.

8A. INSECT PESTS (FROM DEPARTMENT OF PRIMARY INDUSTRIES, QUEENSLAND)

Common soil insects in corn include the following:

Black field earwigs

(*Nala lividipes*) are shiny black insects (up to 15 mm) with a pair of forceps or pincers at the rear end. The immature stages resemble adults but are wingless. They attack seeds, shoots, roots and stems at/or below ground level.

Populations are regulated by soil moisture and serious damage is usually confined to soils that retain moisture well.

Note: There are beneficial earwigs. These are usually larger and light brown in colour.

False wireworm

(*Gonocephalum spp., Pterohelaeus spp.*) are cylindrical, yellow-brown beetle larvae with rounded heads. They attack germinating seeds and seedling roots and shoots and are most active in spring. The beetles feed on dry seed in the ground especially in dry soil conditions. They only tend to become a problem if large numbers are present during dry conditions. Control using chemicals at planting, treated seed and insecticidal grain baits.

KNOWING IF INSECTS ARE PREVALENT IS THE FIRST MANAGEMENT STEP – DON'T BE CAUGHT UNAWARES ON ANY SOIL TYPE.

Cutworms

(*Agrotis spp.*) are caterpillars up to 50 mm in length. Their colour varies greatly. Often they are grey-brown but may range from green or pale yellow to almost black.

Cutworms feed on leaves and stems of young plants, with most damage caused by older caterpillars that may cut down plants to eat the leaves. They may also cause the plant to wilt by partially chewing on stems. Cutworms usually feed at night and hide in the soil during the day. Cutworms may be found in any soil type and often move into the crop from adjoining fence lines, pastures or weedy fallows.

Spray with chlorpyrifos when caterpillars are feeding (dusk-night). Spot treatments may be successful (refer to the supplier's product label before application of any agricultural pesticide). Keep fallows clean and eliminate weeds from paddock perimeters for at least one month before planting.

Wireworms

(*Family Elateridae*) are up to 40 mm long and can vary greatly in shape. They may have soft, flat, creamy-white or pale bodies with dark wedge-shaped heads and forked tooth-edged tails, or have hard smooth round yellow to red-brown bodies with flattened, round or cone-shaped tails.

Wireworms can feed on seed but usually attack underground stems of young plants, killing the growing points and causing shoots to wilt. Damage is worse when crop growth is retarded by dry, wet or cool conditions. Wireworms generally favour moist areas. Plant treated seed or use in-furrow application of insecticide.

01: Black field earwigs
02: False wireworm
03: Cutworms
04: Wireworms

Above-ground pest control baiting

Above ground pests such as African black beetles, false wireworm beetle, field crickets, wingless cockroaches and black field earwigs can be controlled by spreading a bait of Lorsban 500EC and sunflower oil on a base of cracked wheat, sorghum or corn.

Best results can be achieved by broadcasting the bait evenly over the soil surface immediately after planting. This way insects will be controlled before the seedlings emerge. Apply the bait at 2.5 kg/ha to 5 kg/ha for most effective control. You can make your own bait using the following combination: 100ml of lorsban 500EC+ 125ml of sunflower oil on 2-5 kg of cracked wheat, sorghum or maize. Wearing appropriate personal protection equipment, mix the lorsban 500EC and sunflower oil together first, then mix in thoroughly with the cracked grain. Spreading of the bait can be done by a variety of processes; including modified fertiliser spreader, modified granule application and air seeder.

Other insects

Heliothis or corn earworm (*Helicoverpa armigera*) caterpillars are up to 50 mm in length. They can vary in colour from yellow to almost black – often with a broad pale stripe along each side. Eggs tend to be laid anywhere on the top two thirds of the plant. Heliothis are a more serious pest during tasselling and silking. The damage to the silks reduces pollination and grain-set (6-8 larvae per tassel before silk emergence may warrant control). Chemical control should only be aimed at small caterpillars (up to 5 mm), as heliothis have developed resistance to a wide range of chemicals. Before spraying, consider that corn crops often have high levels of beneficial insects (predators and parasitoids) that may be harmed by insecticidal applications. Some biological insecticides with minimal toxicity to beneficials are available.

Corn leafhopper are small, brownish, translucent insects with dark eyes that spring away (hop) rapidly when disturbed. More than 15 per plant can cause a disease-like condition known as wallaby ear. Plant resistant varieties.

Thrips may damage crops that are stressed and not growing well. Infected plants may have yellow or silvery patches on the leaves of young plants and a desiccated or wilted appearance. Look in the whorl of the individual corn plants for the presence of very small, brown/black insects measuring 1-2 mm in size. Control with insecticides. Check with your grain buyer as to which chemicals can be used for the particular target market.

05: Heliothis or corn earworm

06: Thrip damage of young corn plants

07: Corn aphids being predated by a lady bird larvae

08: Spider mite damage

Green vegetable bug

Adult bugs are 12 to 17mm long, shield-shaped and light green or green with three cream-coloured spots on the anterior margin of the large, central, triangular portion of the back. The immature stages are marked with red, green, white, yellow, orange and black.

Adults and late stage nymphs may stunt or deform young cobs by feeding at their bases. They may also pierce the husks and puncture the grains. Damaged grains do not develop, or may become dry and shrivel.

Corn aphid

The corn aphid is a minor pest, although it can transmit the virus that caused maize dwarf mosaic. Large colonies sometimes form on the undersides of the leaves, in the funnel or throat of the plant, on the tassels and on the silks and husks of the cob. During dry weather very heavily infested leaves may turn yellow or red and shrivel.

Adult corn aphids are about 1.5 to 2 mm long, winged or wingless, and soft-bodied with greenish abdomens, but the head, the forward portion of the body the legs and antennae are blackish brown. The immature aphids resemble the adults in shape and colour but are wingless.

Infestations are normally controlled by natural agencies including the weather, ladybird beetles, parasitic wasps and larvae of hover flies.

Two-spotted spider mite

Adults and nymphs are similar in appearance. Both have a dark spot on each side near the middle of their yellow-green body. Adults are 0.5 mm in length. Infestation generally starts late in the corn crop's vegetative stage, increases after tasselling and dramatically increases after the grain is at the soft dough stage. Hot dry conditions promote rapid population increase. Mites colonise the underside of leaves and can be recognised by the characteristic webbing over the colonised area.

Damaged leaves are chlorotic and brown and senesce prematurely. Mites normally start feeding on lower leaves then move up the stem as new leaves are produced and old leaves senesce. Severe infestations can cause yield loss through reduced cob size, reduced grain size and lodging.

There are no insecticides registered for the control of two-spotted spider mite. Thrips and predatory mites are predators of two-spotted spider mite and insecticides which reduce the number of these predators (eg synthetic pyrethriods) may flare mites leading to higher pest pressure and subsequent crop damage.

9 CHOOSING A CORN HYBRID

SELECTING A CORN HYBRID IS A VERY IMPORTANT ASPECT OF ALL CORN PRODUCTION PROGRAMS. ONCE A FARMER HAS DECIDED TO INCLUDE CORN IN THE FARM PROGRAM, ONE OF THE MOST IMPORTANT MANAGEMENT DECISIONS IS TO CHOOSE THE MOST APPROPRIATE HYBRID TO SATISFY THE FARM AND MARKET REQUIREMENTS.

Pioneer is recognised around the world for being the leading provider of corn hybrids. Approximately US$450 million is spent on research annually. This investment combined with a proven testing program enables Pioneer hybrids to be industry leading performers.

In order to minimise any confusion when choosing a hybrid, there are a number of factors to be considered.

These are:

9A. MARKET REQUIREMENTS

In the past, corn was grown primarily as stockfeed. However, the end-use of corn has diversified to such an extent that the market a farmer is trying to satisfy will largely determine the hybrid they choose. Hybrids differ in texture, varying from soft and floury to hard and flinty.

The market requirements for corn are:

Stockfeed

Any type of corn can be used as a stockfeed but this description is usually applied to the softer, floury grain types. Corn competes in the marketplace with feed wheat and sorghum, and usually commands a premium above sorghum prices.

Processing

Not all corn hybrids are suitable for processing, and the processing companies have lists of hybrids suitable for their particular purposes. Corn chip and cornflake manufacturers require a grain with a hard flinty endosperm. Corn flour processors require soft, floury grain. It is very important to confirm with the companies concerned that a particular hybrid is in fact suitable for their requirements, and that they will be buying grain. A premium is often paid for processing corn and growers usually contract with the relevant company prior to planting.

Specialty corns

High Amylose Corn

"High amylose" corn is a term used to describe a particular type of corn grain that has been selected using traditional breeding techniques to increase the amount of amylose starch in the grain.

Normal field corn contains a combination of 2 types of starch:

- Approximately 70% amylopectin starch, which is a highly branched molecule
- Approximately 30% amylose starch, which is a linear molecule.

In high amylose corn, the ratio of starch has been modified and the amylose proportion increased to 70+%. Pioneer Australia and Ingredion have a joint breeding program that has been working for the last 15 years to develop high yielding, gronomically suitable high amylose hybrids for the Australian market.

High amylose corn is grown under contract to Ingredion. Being a recessive gene (hence required on both sides of the pedigree) it needs to be grown in isolation from normal corn. Check with Ingredion regarding time and/or distance isolation requirements.

The starch is extracted by Ingredion at their plant in Lane Cove, Sydney. The extracted starch is an enriched source of total dietary fibre and resistant starch, and is used in various manufacturing processes as a fine, white, free-flowing powder, with no off odours or flavours.

High amylose starch is used as a fibre source in bakery products, bread, breakfast cereals, pasta and noodles, snack foods, soups, cereal drinks, yoghurt and select dairy products.

Pioneer Hi-Bred Australia has a number of high amylose hybrids suitable for the Australian market. Contact your local Pioneer Area Manager or Ingredion (0439 392324) for more information.

PIONEER HI-BRED AUSTRALIA AND INGREDION HAVE A JOINT BREEDING PROGRAM THAT HAS BEEN WORKING FOR THE LAST 15 YEARS TO DEVELOP HIGH YIELDING, AGRONOMICALLY SUITABLE HIGH AMYLOSE HYBRIDS FOR THE AUSTRALIAN MARKET.

Waxy Corn

Waxy corn is a term used to describe a particular type of corn grain. Originally discovered in China, but not grown in large quantities until World War II when processors needed a replacement for tapioca maize, it is a naturally occurring genetic mutation.

Normal field corn contains a combination of 2 types of starch:

- Approximately 70% amylopectin starch, which is a highly branched molecule
- Approximately 30% amylose starch, which is a linear molecule.

In waxy corn, the starch consists of 100% amylopectin starch.

The starch is extracted by the wet milling industry and the particular properties of the starch (including easy to gelatinise) are utilised in a wide range of products including:

- Thickening fruit pies
- Freeze-thaw stability of frozen products
- Smoothness and creaminess of canned food and dairy products
- Production of maltodextrins
- Adhesives for bottle labels
- Gummed tape and envelope adhesives

Waxy corn is usually grown under contract. Being a recessive gene (hence required on both sides of the pedigree) it needs to be grown in isolation from normal corn. Check with the end-user regarding time and/or distance isolation requirements.

Feeding studies have also shown a positive increase in feed conversion efficiencies in dairy cattle, beef cattle and lambs, however there has been no widespread adoption by the intensive animal industries.

Silage

Corn grown for silage has increased over the past 15 years with both dairy and beef producers utilising corn silage as part of their feed supply. Corn grown for silage provides high dry matter production per hectare and per megalitre used to grow the crop. Generally due to the high dry matter yield of corn, corn silage can be grown and conserved very economically to provide a cost effective feed source. Corn silage fed in rations complements high energy supplements, annual pastures and other crops utilised in rations, as it is a feed source that provides energy and some fibre for the herd. Corn silage has a number of other herd health benefits when incorporated into the feed supply. Feeding corn silage puts condition on cows, helps improve conception rates and provides an excellent base to rations.

Earlage

Earlage is an opportunity for livestock producers that want an energy dense feed that has significant fibre content. Earlage is conducted at, or soon after physiological maturity when the grain moisture is approximately 30 percent. Earlage is harvested using the same forage harvesters used in the silage making process but uses a snapper corn front (similar to those used on conventional grain harvesters) to remove the cob portion of the plant.

The grain, the core of the cob and some husk is chopped and processed by the forage harvester and then transported and stored under the same process as whole plant silage would occur. Optimum moisture content for earlage should be 35-40 percent.

It is important that earlage be treated with a proven silage inoculant such as Pioneer® inoculants 11C23 or 11CFT to improve the feeding efficiencies of this high quality product.

High moisture corn (HMC)

Firstly, HMC is harvested soon after physiological maturity at a grain moisture content of 24-32 percent. It is harvested by a conventional grain harvester, and then is processed (preferably through a roller mill) and stored in a well designed, above ground bunker similar to that used by silage and earlage products.

As the grain is harvested at high moisture, it allows the grower to harvest the crop significantly earlier than dry grain and gives the opportunity for crop rotations. By processing the product prior to ensiling, it does not require further processing at feed out time. This is seen by some larger producers to be an advantage if untimely equipment failures occur when trying to feed stock.

Like earlage, HMC is a high quality product and every management tool should be used to minimise losses and maximise feeding efficiencies. Therefore, it should be treated with Pioneer® inoculant 11C23 or 11CFT to assist in its feeding characteristics,

HMC is not a long term stored feed source like whole plant corn silage. While whole plant corn silage can last for many years in a well designed and sealed storage structure, HMC should be used within 12 months of harvest as quality will deteriorate quite rapidly after this time.

INVESTMENT COMBINED WITH A PROVEN TESTING PROGRAM ENABLES PIONEER HYBRIDS TO BE INDUSTRY LEADING PERFORMERS.

CORN HYBRIDS ARE RATED FOR MATURITY BY COMPARING THE MOISTURE AT HARVEST WITH A STANDARD HYBRID.

IT Corn

Corn with the suffix IT is commonly known as 'imi' corn. Using traditional plant breeding techniques, one or both of the hybrid parents are backcrossed to a known source of the IT gene. When a hybrid has only 1 parent with the IT gene it is known is imidazolinone tolerant (IT).

The availability of IT corn hybrids offers options in our cropping systems:

1. "Lightning®" (marketed by AgNova www.agnova.com.au) is the only "imi" product registered in Australia for use on corn. A broad spectrum of grass and broadleaf weeds can be controlled or retarded with the use of this chemical, including johnson grass seedlings, barnyard grass and nutgrass. Please refer to the AgNova website for more information.

2. Carryover concerns - If carryover from a previous application of "Lightning®" is a concern, IT corn hybrids can be planted and will have tolerance to such residues. For other imi herbicides, it is important to check the label of the herbicide in question or contact the manufacturer before application as plant back periods may be subject to change without notice. Listed below, is the minimum plant back periods for the following products as seen on chemical company websites:

    > Spinnaker® – 0 months
    > Flame® – 3 months
    > Intervix® and Onduty® – 34 months

White Corn

White maize is fast becoming a highly sort after grain by the stockfeed sector (including poultry and dairy) with several of the major end users committing to forward contracts prior to planting.

There are a number of opportunities to export the grain to Asia and there is demand from the high moisture grain markets as well. White maize is also highly suitable for silage use with top ranking scores for silage yield for maturity.

9B. MATURITY

Corn hybrids are rated for maturity by comparing the moisture at harvest with a standard hybrid. This is called the Comparative Relative Maturity (CRM) and is commonly referred to as the days from planting to physiological maturity (also known as black layer). However the actual number of days taken to reach black layer will vary greatly with location, planting time, and other environmental factors. Black layer refers to the time when the corn kernels have reached their maximum weight, and can be identified by the development of a layer of black cells at the base of each kernel. From this stage on, no further starch is laid down in the kernel, the plant dies and the grain dries down until it reaches harvest moisture.

Under most Australian growing conditions, hybrid maturity is not as critical as in many overseas corn growing areas. Our growing season is very long, and a wide range of maturities can be planted at most planting dates. Maturity becomes more critical in southern growing areas.

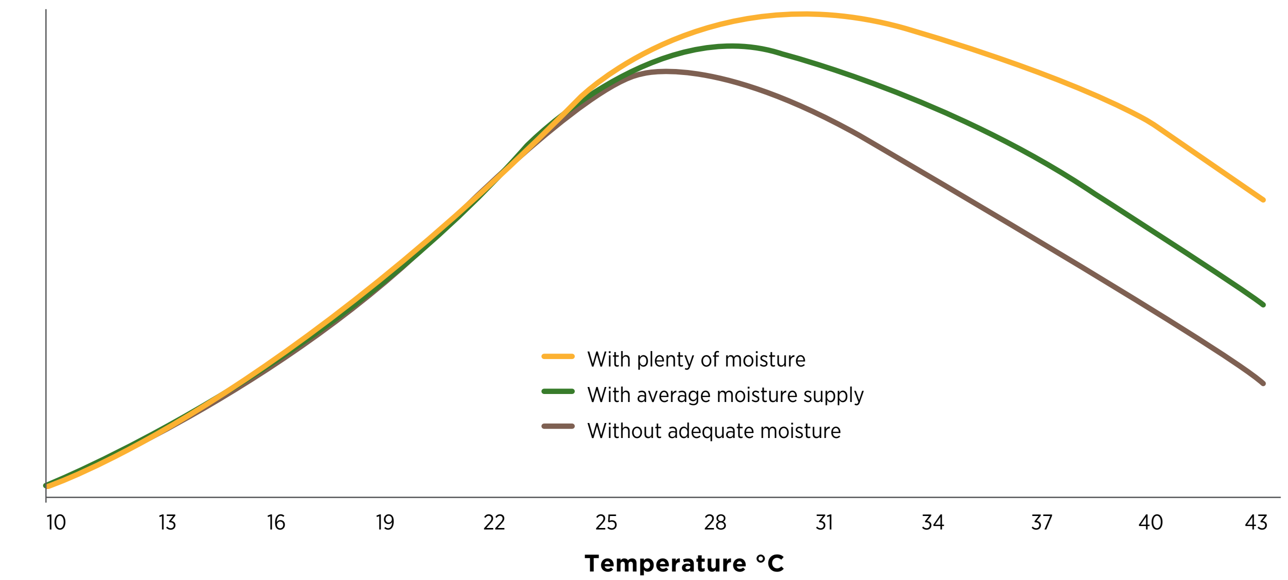
The important points to consider are:

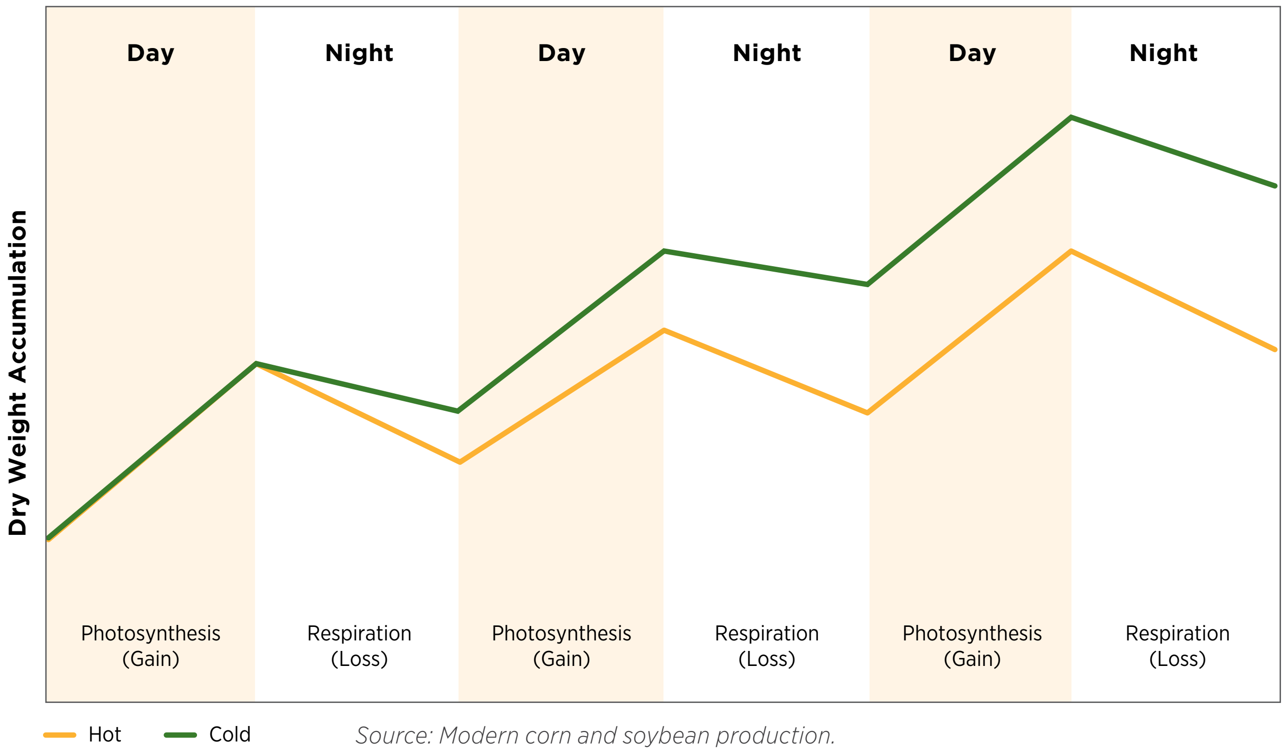
- Try to avoid excess heat at flowering.
- Plant several different maturities to spread risk, to suit water application, and to optimise yield and market opportunities.
- On a late plant it may be necessary to plant a quick maturing hybrid in order to avoid frost damage prior to reaching black layer. However, disease pressure must be carefully considered when selecting quicker maturity hybrids. In some environmental conditions they may be susceptible to leaf and cob diseases.
- Generally speaking and especially under ideal growing conditions, a longer maturity hybrid has a higher yield potential than a quick maturity hybrid. However, advances in plant breeding have lifted the yield potential of the quick and mid-season hybrids to such an extent that their yield potential can be comparable to full season hybrids. Obviously each hybrid has to be planted at its optimum plant population.

Another aspect of maturity is the rate of dry down. This is the time taken from black layer to harvest moisture, and is an area where plant breeders have made big gains in recent years. The rate of dry down has been maximised, while at the same time increasing yield and maintaining plant health and standability.

HIGH TEMPERATURES, ESPECIALLY WHEN COUPLED WITH LOW HUMIDITY, CAN SERIOUSLY AFFECT THE REPRODUCTION STAGE OF THE CORN LIFECYCLE AND SIGNIFICANTLY REDUCE YIELD.

Figure 12: The relation of temperature to rate of growth





Source: Modern corn and soybean production.

9C. TOLERANCE TO HEAT AND MOISTURE STRESS

All plants have a range of environmental conditions under which they perform best and corn is no exception.

In the case of corn, plant growth is reduced when temperatures exceed 30 degrees and drop below 10 degrees with an optimum temperature for growth of 22-24 degrees. High temperatures, especially when coupled with low humidity, can seriously affect the reproduction stage of the corn life cycle and significantly reduce yield.

Breeding efforts in many parts of the world have concentrated on selecting hybrids that can tolerate heat and moisture stress, and current hybrids differ greatly in their ability to handle stress. This is particularly important in dry land environments, and even in irrigated fields the plants can be stressed for short periods.

The most obvious external effect of stress on a corn plant is the delay in silk emergence relative to the onset of pollen shed. Severe silk delay can result in little or no seed-set.

9D. DISEASE AND INSECT RESISTANCE

It is important to choose a hybrid that can tolerate diseases that may be encountered during the growing season. The incidence of disease will depend on many factors including location, environment, cultural practices and planting date.

Rot diseases in corn

Rots in corn can be caused by a wide range of fungal pathogens.

Some of the more common are:

Fusarium Ear Rot

Disease Facts

- Most common fungal disease on corn ears
- Caused by *Fusarium verticillioides* (previously known as *Fusarium moniliforme*) and several other Fusarium species
- Fungi survive on residue of corn and other plants, especially grasses
- Infection can occur under a wide range of environmental conditions. Disease is more severe when weather is warm and dry
- Disease enters ear primarily through wounds from hail or insect feeding
- Insects damage husks and kernels and may also vector Fusarium spores
- Ear rot severity is usually related to severity of Heliothis feeding damage
- Airborne spores can germinate and grow down the silk channel to infect kernels

09: Insect feeding damage

10: “Starburst” pattern often associated with the disease (light-colored streaks radiating from top of kernels where silks were attached)

11: Fusarium fungus

12: Left – no insect feeding or disease symptoms, Right – insect feeding allowed entry of Fusarium fungus with resulting symptoms

Impact on Crop

- Yield and grain quality are reduced
- In severe infections, ears may be completely consumed by the fungus, leaving lightweight husks cemented to the kernels by mycelia
- *Fusarium verticillioides* and *Fusarium proliferatium* produce fumonisins, the most commonly occurring mycotoxins in the Corn Belt
- Fumonisins can be fatal to horses and pigs
- Fumonisins can damage organs in other mammals and are carcinogenic

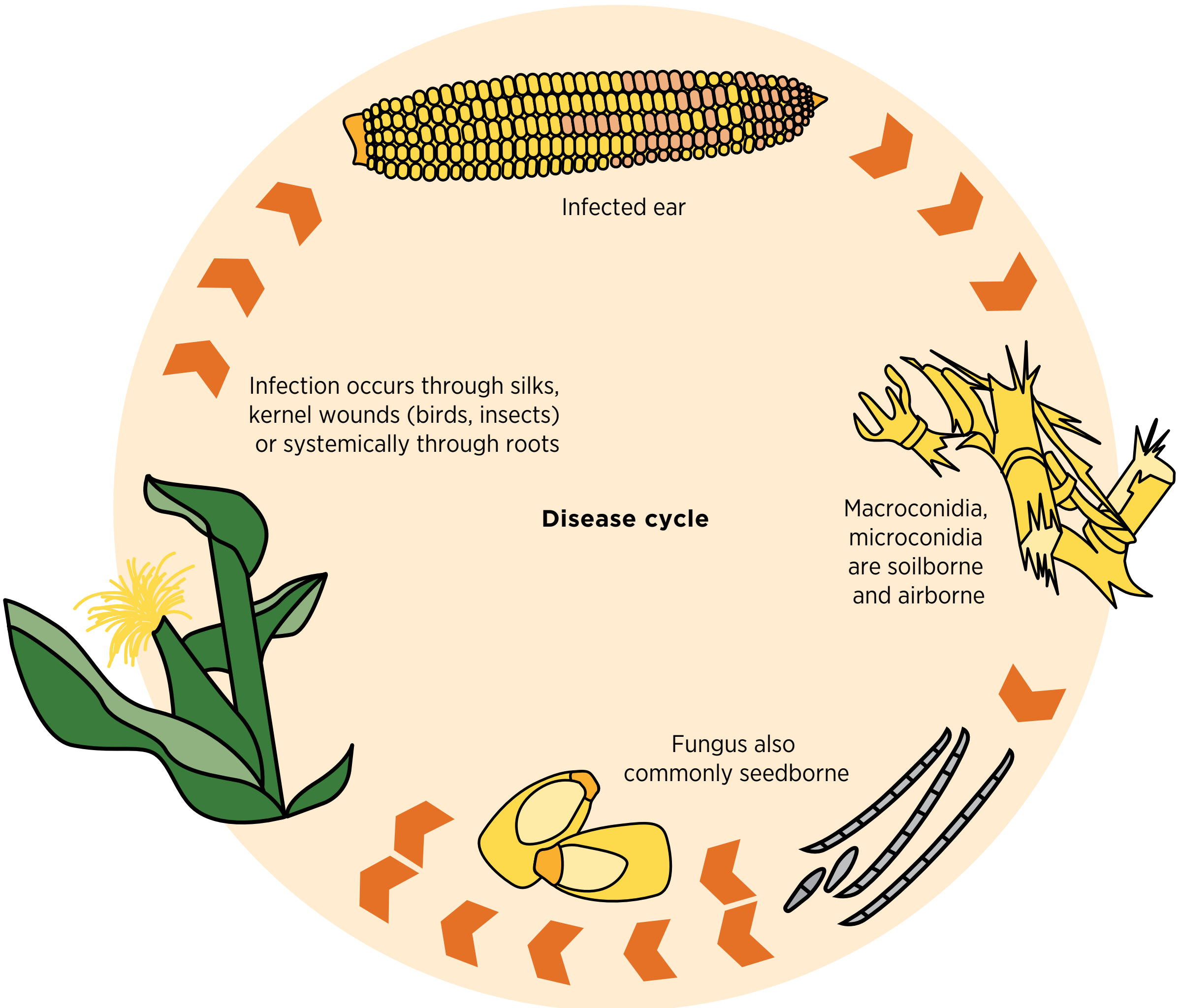
Disease Symptoms

- Scattered or groups of kernels are typically affected
- Mold may be white, pink or salmon-colored
- Infected kernels may turn tan or brown

"Starburst" pattern often associated with the disease (light-colored streaks radiating from top of kernels where silks were attached)

Management

- Choose hybrids with resistance
- Fusarium tolerance ratings range from 3 to 9 for Pioneer hybrids world wide (9=resistant), indicating important differences between hybrids
- If Fusarium ear rot has caused significant damage in the past, growers should only consider planting hybrids with a fusarium ear rot rating of 6 or higher.
- Rotating out of corn for a year is beneficial
- Tillage to bury or breakdown crop residue is helpful
- Rotating out of corn for a year may be beneficial
- Tillage to bury or breakdown crop residue is helpful



Gibberella stalk rot (*Gibberella zeae*)

Very common on the Atherton Tablelands, especially in the wetter parts, where it can cause serious yield loss. The disease is much less serious in southern Queensland. It occurs in wet weather and where there is plant stress during grain fill. It is common where corn monoculture is practised. Plants die prematurely.

The stalk rots, showing internal tissues that are shredded and discoloured (may be pink or quite red). Stalk surfaces show a reddish brown discolouration, particularly around the nodes. Affected stalks are weak and break easily. Later in the season small, round, bluish-black fruiting bodies may be found around the nodes of dead stalks.

Use crop rotation and/or resistant corn hybrids to combat this disease.

Gibberella ear rot or pink ear rot (*Gibberella zeae*)

A disease of tropical and subtropical regions, especially wetter areas. Particularly significant on wetter parts of the Atherton Tablelands. Apart from causing yield loss it can produce a toxin (*zearalenone*), which is harmful to livestock, especially pigs. Infection is favoured by wet weather, corn monoculture or plant stress during grain fill.

A reddish-pink or whitish-pink fungal growth from the tip of the ear to the base is usual, although infection can occur whenever damage occurs in the ear. Husks tend to bind to the kernels and there may be black fruiting bodies on external husk leaves. Infection is transmitted through windborne spores.

Choose resistant hybrids and control weeds to reduce humidity in the crop canopy (high humidity promotes infection).

This disease has occurred on the Darling Downs in some seasons, especially when summer rainfall has been below average.

There is little information available on the relative susceptibility of different hybrids to this disease. Husk cover and pendulous ears reduce the incidence of this disease.

Losses due to ear rots can also be reduced by prompt harvesting, even if moisture levels are slightly higher and drying is necessary.

Wallaby ear in corn

The physiological condition known as wallaby ear is caused by toxin injected by the leafhopper (*Cicadulina bimaculata*) while feeding. The condition is more common in subtropical coastal areas where it can have a serious effect on yield. Leaves of affected plants are dark green or blue-green in colour. They are short and held at a very upright angle, and veins on the lower leaf surface are thickened. Control of leaf hoppers with registered insecticide when plants are young may be beneficial.

Blight in corn

Leaf blight

Turcica/turcicum leaf blight or northern leaf blight (*Exserohilum turcircum*) can be found in all regions and may be serious in susceptible hybrids. Warm wet weather favours infection and disease development.

Leaves show long, spindle-shaped, greyish-green, water-soaked spots (up to 150 mm x 20 mm), which turn light purplish-brown or grey. In favourable conditions the spots may join, blighting almost the entire leaf. The fungus survives on volunteers and residues and is spread by wind and rain.

Choose resistant hybrids and avoid sequential plantings (stops disease build-up) as chemical control is usually not economic.

Smut in corn

Smuts are not as common as rusts, and usually attack the plant's reproductive components rather than the leaves or stems.

Boil smut (*Ustilago saydis*) attacks any aboveground growing part of the plant to form blisters or galls containing black spores. Mature galls can grow as large as 20 cm in diameter. Spores can be spread by wind, seed, clothes or farm machinery, and can survive in the soil for many years. Ensure good hygiene and treat seed with registered fungicide.

Rust in corn

Common rust (*Puccinia sorghi*) is commonly found in temperate and sub-tropical regions. Usually only found on lower leaves of resistant hybrids. Tends to be more serious on sweetcorn. Cool-warm humid weather favours disease infection and development. Pustules are oval to elongate on the leaf with a mass of red-brown powdery spores. These sometimes turn black late in the season. Plant resistant hybrids as chemical control is not usually economic.

Polysora rust or tropical rust or southern corn rust (*Puccinia polysora*) is an important disease in tropical areas. Warm, wet weather favours infection and disease development. Drizzly rain or even heavy dews allow disease formation. Pustules are small circular and orange in colour. They are evenly spread over the leaf surface. Pustules on the midribs, ear husks and tassels may be elongated or irregular in shape. With heavy infections, leaves may die prematurely, and defoliate from the base up. Plant resistant hybrids as chemical control is not economic.

9E. MULTIPLE COBBING

All corn plants have the ability to produce more than one cob. Some hybrids produce multiple cobs more than others. Hybrids that do not produce many double cobs are more likely to have a greater ability to flex the primary ear size. In a high yielding environment, yields will be maximised if farmers aim to produce one good ear per plant.

Therefore, the decision should not be to select a hybrid on its ability to double cob, but rather on its overall yield performance whether this is done by a single cob or more.

9F. HUSK COVER

Husk cover is important in environments where the maturing grain can be damaged by weather or ear rots.

In some hybrids the ear is borne on a long shank and, as the ear matures, it tends to hang down and thus be protected. In hybrids with a short shank, the ear is held upright and it is important to have good husk cover in order to protect the ear.

9G. TILLERING

Some hybrids can produce 1-2 tillers and this is generally considered an undesirable trait in corn hybrids. This does not necessarily mean that hybrids that produce tillers are any less efficient, or will be any lower yielding than hybrids that don't produce tillers. As well as genetic differences between hybrids, the following factors appear to increase the incidence of tillering:

- Cooler temperatures early in the growing season
- Lower plant populations
- High levels of soil fertility relative to the plant population.

In some situations, hermaphrodite ears may form at the top of the tiller. In most cases early formed tillers reflect favourable growing conditions and tend to die off (with nutrients transferred to the main stem) as the season and crop progresses.

CHOOSE DISEASE RESISTANT HYBRIDS AND AVOID SEQUENTIAL PLANTINGS (STOPS DISEASE BUILD-UP) AS CHEMICAL CONTROL IS USUALLY NOT ECONOMIC.

Tassel-ears in Corn

The male and female reproductive organs of a corn plant are contained in physically separate unisexual flowers (a flowering habit called "monoecious" for you trivia fans.) The tassel represents the male flower on a corn plant, while the ear shoots represent the female flowers. Interestingly, both reproductive structures initiate as perfect (bisexual) flowers, containing both male and female reproductive structures. During the normal course of development, the female components (gynoecia) of the tassel and the male components (stamens) of the ear shoots abort, resulting in the unisexual flowers we come to expect.

Once in a while, the normal development of the tassel alters such that it becomes partly or mostly female reproductive structures, often resulting in actual kernel development. The physiological basis for the survival of the female floral parts on the tassel is likely hormonally-driven, but the environmental "trigger" that alters the hormonal balance is not known.

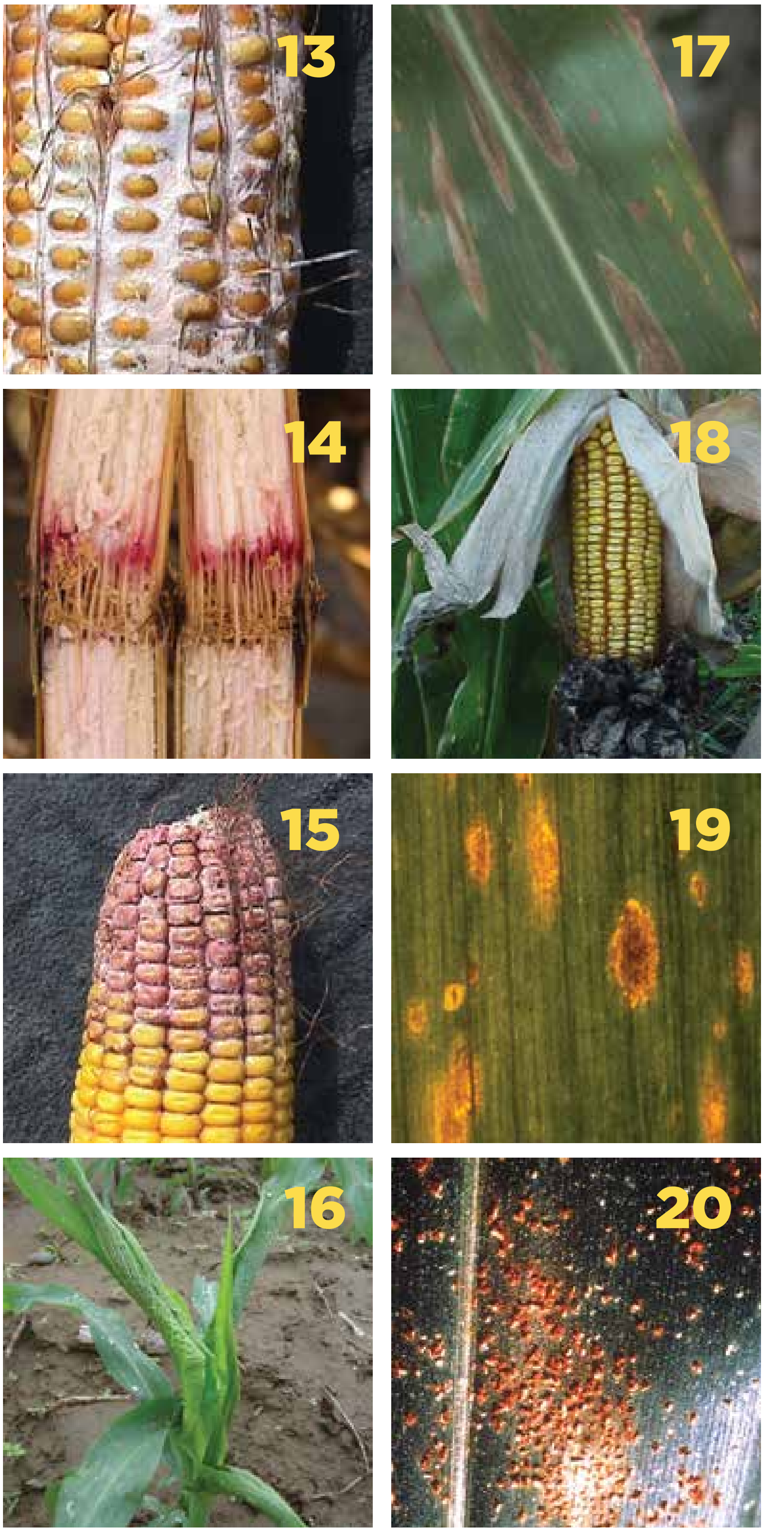
A "tassel-ear" is an odd-looking affair and is found most commonly on tillers or "suckers" of a corn plant along the edges of a field or in otherwise thinly populated areas of a field. It is very uncommon to find tassel-ears that develop on the main stalk of a corn plant.

Without a protective husk covering, the kernels that develop on tassel-ears are at the mercy of weathering and exposed to hungry birds. Consequently, harvestable good quality grain from tassel-ears is rare.

Some folks lump the tassel-ear symptom into the same category as the malformed tassel symptom of the so-called "crazy top" disease. These two odd tassel symptoms are not related and, in fact, look totally different. The 'crazy top' disease is caused by infection of young corn plants during ponding events by the soil-borne fungus Sclerophthora macrospora that eventually expresses itself by altering normal tassel development (and sometimes ear shoot development) into a mass of leaf tissue.

Rootless corn syndrome

Rootless corn occurs in plants with poorly developed root systems and is usually observed in plants from about the three- to eight-leaf stage of development. Plants exhibiting rootless corn symptoms have either lodged and are laying on the ground or are about to lodge. Sometimes the corn will only be anchored in the soil by a single nodal root or by seminal roots. Before the problem is evident, corn plants may appear vigorous and healthy but can fall over due to limited or no support later. Affected plants lack all or most nodal roots; existing nodal roots may appear stubby, blunt, and not anchored to the soil. Due to a lack of root mass, the affected plants can be expected to wilt, have stunted growth, or eventually die in extreme conditions.



13: Fusarium kernel rot
14: Fusarium stalk rot
15: Gibberella ear rot or pink ear rot
16: Wallaby ear in corn

17: Leaf blight
18: Boil smut
19: Common rust
20: Polysora rust

What type of environment causes this poor root development?

Under normal field conditions, seeds absorb moisture and growth begins. The radicle emerges from the seed, which is soon followed by the coleoptile. Plant emergence occurs due to rapid mesocotyl elongation, which pushes the coleoptile to the soil surface.

Corn has two root systems that are easily visible early in the year: seminal and nodal. The initial root system, the seminal roots, is comprised of the radicle and lateral seminal roots. The seminal roots help anchor the young seedling and provide it with nutrients and water. Seminal roots cease new growth shortly after the coleoptile emerges from the soil surface.

Nodal root growth develops at the base of the coleoptile (at the junction of the mesocotyl and coleoptile). They should form approximately 1 to 1.5 inches below the soil surface. Once the plant is approximately V1, the nodal root system is visible.

Seminal root growth slows after seedling emergence. Although the seminal roots continue to function throughout most of the plant's life, their most important contribution comes before the nodal roots are established. The nodal roots are important in providing the majority of the water and the mineral nutrients that the corn plant needs for growth and development after V6.

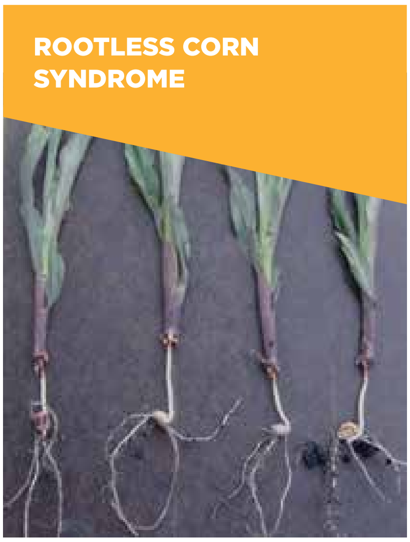
Many investigators have attributed rootless corn problems to weather-related conditions that coincide with development of the nodal root system and other environmental factors. These include hot, dry surface soils, shallow planting depths, compact soils, and loose or cloddy soil conditions. With loose soils or with rotary hoeing, coleoptiles are exposed to light sooner than normal, and nodal roots may form closer to the soil surface. Abrasive action of strong winds can also break off secondary roots and inhibit establishment of a permanent root system. Excessive rainfall and shallow planting depths may cause erosion and soil removal around the crown region that can result in rootless corn.

Although certain types of herbicide injury and insect feeding may cause lodging to occur in corn plants during vegetative development, generally there has been little evidence of their involvement in causing rootless corn. Nevertheless, there may be situations where insect feeding and/or growth regulator herbicides (e.g., 2,4-D and dicamba) appear to contribute to rootless corn problems. Wait to apply herbicides if significant portions of the field show this rootless syndrome.

Can rootless corn recover?

Yes, after plants lodge, adequate rainfall will promote nodal root development and many plants can recover. Recovery is severely hampered if conditions are dry.

Cultivation to move soil around exposed roots will aid the corn's recovery, yet this is extremely difficult if plants are laying on the ground or in a no-till situation. Rain or irrigation is the best solution as it moistens the seedbed allowing for root growth and establishment.



Frost Damage in Corn

Corn plants are sometimes exposed to low temperatures during autumn that kill plant tissue before physiological maturity. When an early frost occurs, corn growers need to know the impact of the damage on maturation and yield, and what to do with the frosted crop.

Conditions conducive to frost damage

when air temperature is close to freezing, slight variations in terrain result in frost damage in low-lying areas, with no damage only a few feet higher in elevation. Thin plant stands and plants at the edge of the field are more likely to freeze because of more radiational cooling and less heat contained within the crop cover.

Corn plant parts vary in susceptibility to frost damage. Leaves are most susceptible because their whorl arrangement and thinness make it difficult to retain heat. In contrast, thicker plant tissues with more layers of protection, such as stalks, husks, and grain, have greater heat retention capabilities than leaves. Plant sap and/or cell contents can act as antifreeze to allow the temperature to fall below 0c before tissues freeze. Plant tissues vary in concentration of these contents, and this might also cause variations within plants in the actual temperature at which ice crystals form. Upper plant parts are farther from the radiation source than lower parts, and are therefore more likely to be frost-damaged.

Effect of frost damage on grain development and yield

the influence of frost damage on final grain yield depends on how much leaf tissue is killed and the stage of development when the frost occurs. The effect of plant defoliation on grain yield becomes smaller the closer the plant is to physiological maturity (Table 1). Redistribution of sugars from stalks to ears, despite complete leaf death, will increase kernel dry weight beyond that present on the frost date and reduce yield loss, unless the freeze is severe enough to kill stalks, husks, and kernels. If any leaves, especially above the ear, or even the stalk, ear shank, and husk are still green after a frost, grain dry weight will increase until the black layer forms at kernel tips. However, several days of cool temperatures (daily highs of 7 c to 10 c) during grain fill may result in premature black layer formation, ending further grain yield increases even if another frost has not occurred.

When green, very immature (milk to dough stage) corn plants have been frosted, leaves quickly dry, giving the appearance of rapid whole-plant dry down. But leaves comprise a small portion (10 to 15%) of total plant weight and lose moisture rapidly compared to stalk and ears. Numerous studies have shown no evidence of increased whole-plant drying rates following frost.

Many corn growers perceive that kernels from early-frosted corn dry very slowly or not at all in the field. US studies simulating frost damage at early dent stage (approximately 55% kernel moisture) indicated that corn killed immaturely by frost dried normally when environmental conditions favored kernel drying. Dry-down of the frosted corn was temporarily delayed immediately following frost

Handling frost-damaged corn

A visual inspection of frost-damaged corn should be made the morning after the frost, after the sun has risen and the crop has begun to thaw. At this time, cell contents will begin to leak out and can be seen and smelled. Determine how much of the leaf tissue has been damaged and if the ear shank is frozen. If the shank is frozen, there will not be further movement of sugars to the grain.

Table 1

Corn grain yield losses following plant defoliation and immediate harvest at three stages of kernel development, compared to losses when defoliated at same stages and left in the field to mature.

STAGES OF KERNEL DEVELOPMENT	HARVESTED AT DEFOLIATION	MATURITY
% yield reduction		
Soft dough	51-58	34-36
Fully dented	39-42	22-31
Late dent	11-12	4-8

Source: Afuakwa, J. J., and R. K Crookston. 1984 Using the kernel milk line to visually monitor grain maturity in maize Crop Sci. 24:687-691

CHOOSING THE BEST HYBRID

The task of choosing the best hybrid (or hybrids) to plant should be simplified if each of the points discussed above is considered.

Unfortunately there never will be a hybrid that will give full protection to every environmental, disease and insect problem that maybe encountered during the growing season, as well as giving the top yield year in year out.

Therefore it is up to the farmer to obtain as much relevant and unbiased information as possible, list his priorities, and decide the best hybrids for his property.

SOURCES INCLUDE:

01

The Pioneer STRIKE® Trial Data team - particularly as new hybrids are released into the market.

02

Experience from local farmers.

03

Local seed distributors, many of whom conduct their own hybrid testing programs.

IT IS A GOOD IDEA FOR FARMERS TO CONDUCT THEIR OWN STRIP TESTS OF NEW HYBRIDS, AND OBTAIN THEIR OWN INFORMATION BEFORE COMMENCING FULL-SCALE COMMERCIAL PRODUCTION.

PIONEER IS HERE TO ASSIST FARMERS WITH STRIP-TESTS, FROM PLANTING THROUGH TO YIELD TESTING.

10 CORN PLANTABILITY & POPULATIONS

AFTER SELECTING A CORN HYBRID, THE IMPORTANCE OF PLANTING DECISIONS IS OFTEN UNDERESTIMATED AND CAN LIMIT THE YIELD POTENTIAL OF THE SEEDS PLANTED.

Having a good understanding of all aspects of seed and seed plantability can often lead to increases in yield. Errors at planting are evident throughout the season and can have a permanent effect on yield for the remainder of the season.

UNDERSTANDING SEED SIZES

When selecting hybrids, there are many important considerations. Growers should remember that all seed sizes that result from seed production of a specific hybrid are genetically identical. The different combinations of seed size and shape merely reflect the kernels' position on the seed parent ear. The result is that seed from a single ear could fall into many size/shape classes. Large-round classes usually come from the base of the ear, flats from the centre, and small-round seed from the tip.

The harvested seed is graded into different seed sizes. Standard size screens are used each year. However, seed density may change from year to year depending on growing conditions. This results in seed count variations within the different seed sizes as shown in *Figure 12*. The seed dimensions do not change.

SEED SIZE PERFORMANCE

Unfortunately, many myths exist when it comes to seed sizes. Some farmers have the concern that differing seed sizes may not have the same performance.

That is, some seed sizes are better suited to particular types of planters, and some seed sizes have better vigour than others. Independent studies have found that few differences actually exist in emergence, growth, yield and potential performance between seed sizes.

Corn growers should not be concerned if they cannot acquire their seed size of initial choice. Most modern planters have the ability to plant most seed sizes if they are properly calibrated.

Some moisture studies have noted that small seed has shown an advantage in emergence over larger seed as the larger seed requires more moisture to instigate the germination process.

THE IMPORTANCE OF PROPER SEED SPACING

Skips and doubles are common form of planting variability in the corn row. Skips result from planter mishandling of seed, or from failure of seed to emerge. Doubles are strictly from planter mishandling. Both skips and doubles result in plant spacing variability, but their effect on yield can be quite different.

The standard deviation of plant to plant spacing is a statistical tool often used for relating field variation to yield losses: the larger the value, the greater the variability among the measurements. The standard deviation can be calculated by hand using formulas available from Pioneer.

In recent years, there has been some research work completed showing yield losses for uneven plant spacing within the row to be as much as 80 kg/ha per centimetre of standard seed deviation.

Figure 13

SEED SHAPE	SEED SIZE	APPROXIMATE SEED COUNTS
R (Round)	1 = Very large	1800 – 2400 seeds/kg
	2 = Large	2200 – 2800 seeds/kg
	3 = Medium	2800 – 3600 seeds/kg
	4 = Small	3500 – 4000 seeds/kg
	5 = Very small	3800 – 4500 seeds/kg
F (Flat)	1 = Very large	1800 – 2400 seeds/kg
	2 = Large	2200 – 2800 seeds/kg
	3 = Medium	2800 – 3600 seeds/kg
	4 = Small	3500 – 4000 seeds/kg
	5 = Very small	3800 – 4500 seeds/kg

PLANTING DEPTH

Proper corn seed planting depth is critical for optimum root and plant development. Shallow planting corn can delay or inhibit the development of brace roots, which are the primary tools for water and nutrient uptake.

Planting seed to a depth of 3.5-5 centimetres (1.5-2 inches) is optimum for brace root development.

If corn is planted too shallow and the topsoil becomes dry, a condition called 'rootless corn syndrome' can develop. Plants can fall over due to the lack of brace root development in the dry soil.

Shallow planting depths of less than 2.5 centimetres can expose corn seedlings to herbicide residues increasing the potential for herbicide injury to corn seedlings.

Planting depth can easily be determined after seedling emergence. The brace root area (growing point) typically develops about 20 millimetres beneath the soil surface regardless of the seed depth. Measure the mesocotyl length (the area between the seed and growing point) then add 20 millimetres to determine planting depth.

Symptoms of irregular planting depth can be:

- Uneven emergence
- Non-uniform mesocotyl length
- Varying plant height

Slower planting speeds and well maintained units will help to achieve more uniform planting depths.

PLANTER CALIBRATION AND MAINTENANCE

Of all production variables that affect profitability, planter condition is one of the most controllable.

Agronomy and planter equipment need to work together to maximise yield. A systems approach to precision farming:

- Clearly fine tuning planters to achieve the best possible stands should be the goal of every corn grower.
- Planter maintenance should begin when the last paddock is planted. Proper cleaning and storage at that point can save hours of time and effort later.
- Pre-season checks of the seed meters, monitors, drop tubes, row units and drive train should all be carefully examined.

AGRONOMY AND PLANTER EQUIPMENT NEED TO WORK TOGETHER TO MAXIMISE YIELD.

- **Finger pick-up**
- Look for fractures or cracks on the cover lid.
- Clean the unit out regularly.
- Check springs – look for stretched or lazy springs, which may cause doubles and skips.
- Finger wear – flat areas may cause drag on the backing plate, which may in turn cause the flag to vibrate and drop the captured seed.
- Backing plate – Pitting or rust may cause vibration.
- If the bump is worn down, replace the backing plate.
- Replace worn brushes, especially when using small seed.
- Back housing – cleaning the back housing will help reduce vibration.
- Belts – Look for cracks and brittleness in belts.

Fit correctly as per manufacturer manual instructions.

Seed distribution units must align correctly with seed tubes.

Store planter units under cover to prevent rusting and pitting.

Vacuum planters

- Disassemble the planter units and wash the seed meters in soapy water.
- To prevent warping, hang plates on a peg in your shed away from any excessive heat created by corrugated iron walls (to prevent warping).
- Look for warped or cracked plates.
- Check vacuum seals and hoses for cracks.
- Remove any seed treatment build up.
- Brushes must be in good condition.
- Seals must be pliable and be crack free.
- Some units require graphite.
- Check the condition of your seed tube – where lips can affect distribution and seed depth.

Vacuum planter seed size calibration

- Matching your seed plate with your seed size and air pressure is essential.
- Doubles indicate the plate hole size is too large or the air pressure is too high.
- Increase the air pressure if skips appear. If this is ineffective, change your plates to a larger hole size.
- Decrease the air pressure if doubles appear. If this is ineffective, change your plates to a smaller hole size.
- If air humidity is high, talcum powder mixed with seed may help to avoid doubles.
- Disc checks and settings
- It is important that the disc groove, within the soil profile is shaped as a 'V'. Anything shaped as a 'W' is incorrect.
- Set disc angle according to your planter manual to avoid damage to planter tubes.
- Ensure your press wheel assemblies are centred – adequate down pressure is required to exhume air pockets from around the seed.

PLANTING TIME

The four major aspects to consider at planting time

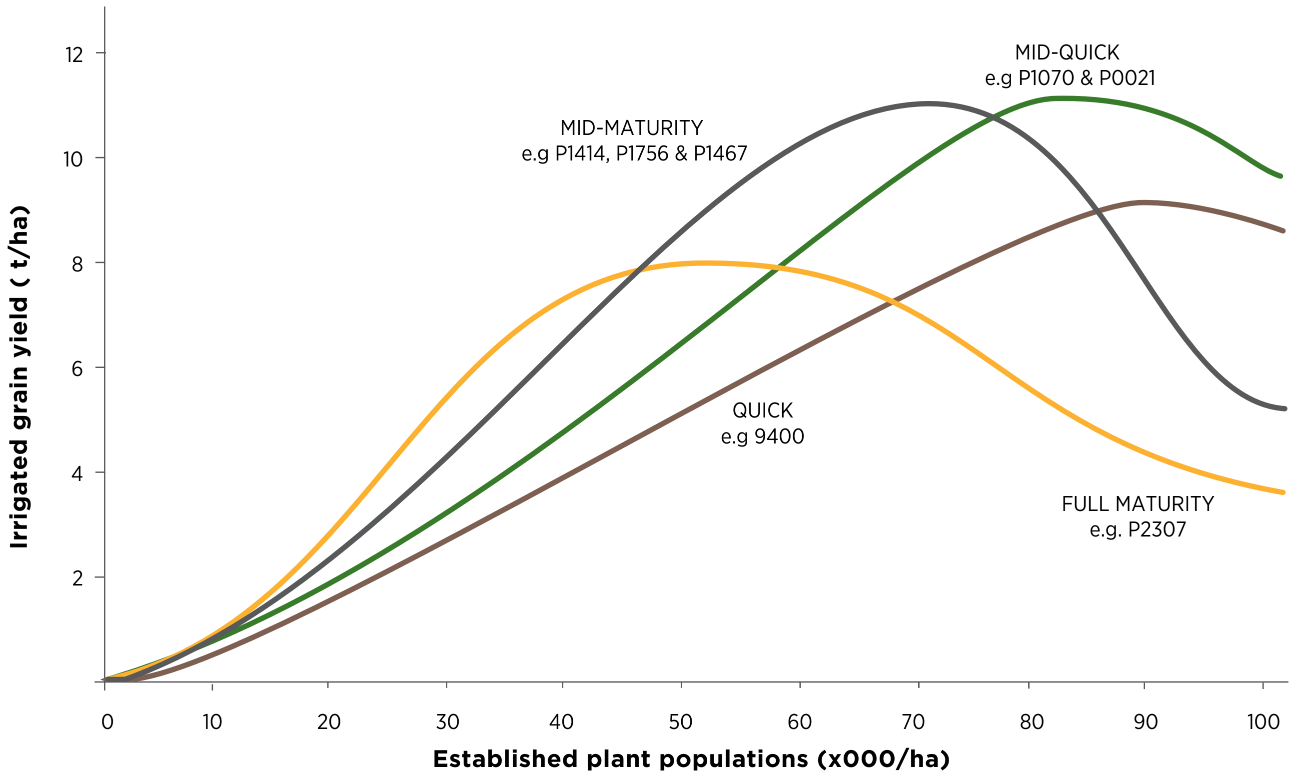
1. Adequate soil moisture to germinate the seeds – a full profile is desirable when planting in dryland conditions.

2. Soil temperature – corn will germinate at 10 degrees Celcius but preferably wait until temperature reaches 12 degrees Celcius and is rising. A soil thermometer is a worthwhile investment.

Under cool soil conditions (10-12 °C), deep plantings could cause significant emergence delays, hence placing the young plant under stress.

- Under warmer soil conditions (15-25 °C), planting corn at 2.5, 5, and 7.5 cm deep has little effect on emergence rates.
- However if planting early (cool season, lower than ideal soil temperatures, adequate soil moisture), growers should consider that shallow planting (approx. 4cm) is warranted, as germination is assured along with the positioning of the growing point and the brace roots.

Figure 14: A guide to the relationship between plant population and yield for various Pioneer® brand corn hybrids under practical irrigation conditions.



3. Heat stress – if possible, plant so that your crop is not flowering during the high heat stress period in mid-summer.

4. Disease and insect pressure – generally speaking, later planted crops have a greater possibility of yield loss due to insect and disease pressure.

It is important to set yield goals. While these goals should be realistic, the majority of Australian corn growers are sacrificing yield by setting their targets too low. The following goals are suggested.

a) Good soil and climate; plenty of water with quick application – 10 to 18 tonnes/ha.

b) Good soil and climate and can apply supplementary water quickly – 7 to 15 tonnes/ha.

PLANT POPULATIONS

Choosing the right plant population is a very important decision. For the purpose of this discussion, it is assumed that weeds and insects are fully controlled and that sufficient fertiliser is applied to achieve the yield goal set.

The main factors influencing yield goal and therefore plant population are:

- Water availability
- Speed of application of water
- Soil type
- Hybrid used
- Planting time
- Planter considerations
- Market requirements (grain or silage).

It is important to understand how these factors influence planting rates.

ROW SPACING

In most Australian situations, row spacing is not the limiting factor in producing high yields. Hybrid selection, plant spacing and good agronomy practices have more impact on achieving high yields. Yields in excess of 15 t/ha (30 DM t/ha silage) and combined with high plant populations (>90,000 plants per hectare). Row spacings as narrow as 37cm have been used.

HYBRID USED

While consideration should be given to the above factors we believe that the major consideration in deciding plant population is your selection of hybrid.

Plant breeders in recent years have been successful in breeding hybrids with higher yield potential and the ability to handle higher plant populations. This has been achieved primarily by selecting plants with more erect leaves and better stress tolerance. This enables crops to intercept more sunlight and cope with stress over longer periods.

Because of the change in plant structure and higher plant population the yields per hectare have increased dramatically although the actual increase in yield per plant has not increased significantly.

While many new hybrids can handle the inter-plant competition generated by higher plant populations, the genetic make-up of the hybrid will dictate the range of plant population recommended for each environment at which that hybrid will give optimum yield and profit responses.

As a rule of thumb, longer season hybrids (longer CRM) require less plants to achieve a given yield than hybrids which mature earlier.

This is because of the longer growing period which allows more sunlight, nutrients, water and oxygen to be converted into starch and grain, thereby developing a larger plant with greater grain yield potential.

The relationship between plant populations and yield for various Pioneer® brand hybrids under irrigated conditions is shown in *Figure 13*. From this the appropriate populations can be calculated for various yield goals. It should be noted that these yield curves are based on actual yield data collected by our research division and should be used as a guide only.

Pioneer plant breeders are continually breaking yield barriers by developing elite hybrids which can continue to yield and stand at much higher populations.

For those not familiar with reading graphs, the following examples will assist:

a) To achieve the peak yield for a mid-maturity hybrid, the estimated population should be approximately 60-80,000 plants per hectare.

b) A quick hybrid, has a peak at a population of approximately 70-100,000 plants per hectare.

MARKET REQUIREMENTS

In almost all situations it is not recommended to increase your plant population above that which will give peak yield production.

Excessive plant populations will give smaller grain size (even if total grain yield does not decrease significantly) and this will reduce mill yields of starch or flinty endosperm for grit production.

If processors offer bonuses for large grain size it may be profitable to reduce plant population by two to five percent under those normally recommended for that hybrid to ensure the optimum combination of yield and grain size, i.e. profit per hectare.

PLANT THE CORRECT NUMBER OF SEEDS

Care must be taken to plant the correct number of seeds to achieve the desired population. Very briefly, final stand depends on the following:

a) Number of seeds planted.

b) Germination and vigour of the seed.

c) Seed bed conditions (moisture, temperature, tilth etc.)

d) Machinery

e) Soil insect control

Don't forget: It is the final population that matters, so increase your desired population by the expected loss of establishment to get the number of seeds that have to be planted.

Example: If you are wishing to establish 60,000 plants/hectare then it is our recommendation to allow for a field loss of an extra 10-15 percent below the actual seed germination. For example, 92 percent germination indicated on the tag in the bag then it would be necessary to plant approximately 72,000 seeds/hectare.

CARE MUST BE TAKEN TO PLANT THE CORRECT NUMBER OF SEEDS TO ACHIEVE THE DESIRED POPULATION.

HYBRID SELECTION, PLANT SPACING AND GOOD AGRONOMIC PRACTICES HAVE THE MOST IMPACT ON ACHIEVING HIGH YIELDS.

11 MAIZE SILAGE

THE RECOMMENDATIONS FOR GROWING A MAIZE SILAGE CROP ARE SIMILAR TO THOSE PROVIDED IN THIS PUBLICATION FOR GROWING A CONVENTIONAL CORN CROP.

Having invested money and time into growing a maize crop it is important to maximise the value of your end product by paying attention to harvest management.

WHEN TO HARVEST

The ideal time to harvest your maize silage crop is when the whole plant dry matter is between 32- 40% (See graph). Harvesting in this window should maximise yield, quality and stack fermentation.

Harvesting a crop too early will result in a yield loss and potentially poor fermentation. High losses will occur as plant fluids run from the stack or bunker taking away valuable sugars. Late harvest may result in a loss of quality as plant stover (leaf and stalk) increase in fibre and becomes less digestible.

Dry crops are also difficult to compact properly, risking the fermentation process.

When crops are grown under irrigation the aim is to ensure the crop is not moisture stressed leading into harvest. Irrigation water should not be cut off to dry the crop out. Grain fill is occurring through to harvest and limiting water will reduce yield.

Timing of the final irrigation should enable the crop to survive on moisture in the soil until the crop is harvested and also allow the field to be dry enough to carry machinery.

The whole plant dry matter can be estimated by looking at the milk line of the grain. Using the milk line to estimate whole plant dry matter and harvest time is only a rough guide and other factors need to be considered such as; overall plant health, timing of last irrigation and water holding capacity of the soil. The best way to measure whole plant dry matter is to sample plants through the paddock, process them and conduct a dry matter test.

Good effective communication between the grower, crop advisor and contractor are vital to ensure harvest is completed at the right time.

CHOP LENGTH AND KERNEL PROCESSORS

The ideal chop length is 10-15 mm. This is a theoretical chop length and you will find some particles that are shorter or longer in your silage.

Some longer particles are beneficial as they stimulate the rumen of the animal that is being fed. If your silage is very dry (greater than 38% dry matter), decrease the chop length to 5-9 mm. In the case of very wet crops (less than 30% dry matter) chop length may be increased up to 20 mm.

A good method of testing whether the chop length that you are using is correct for the moisture level is to take a handful of the harvested maize and squeeze it. The palm of your hand should feel moist.

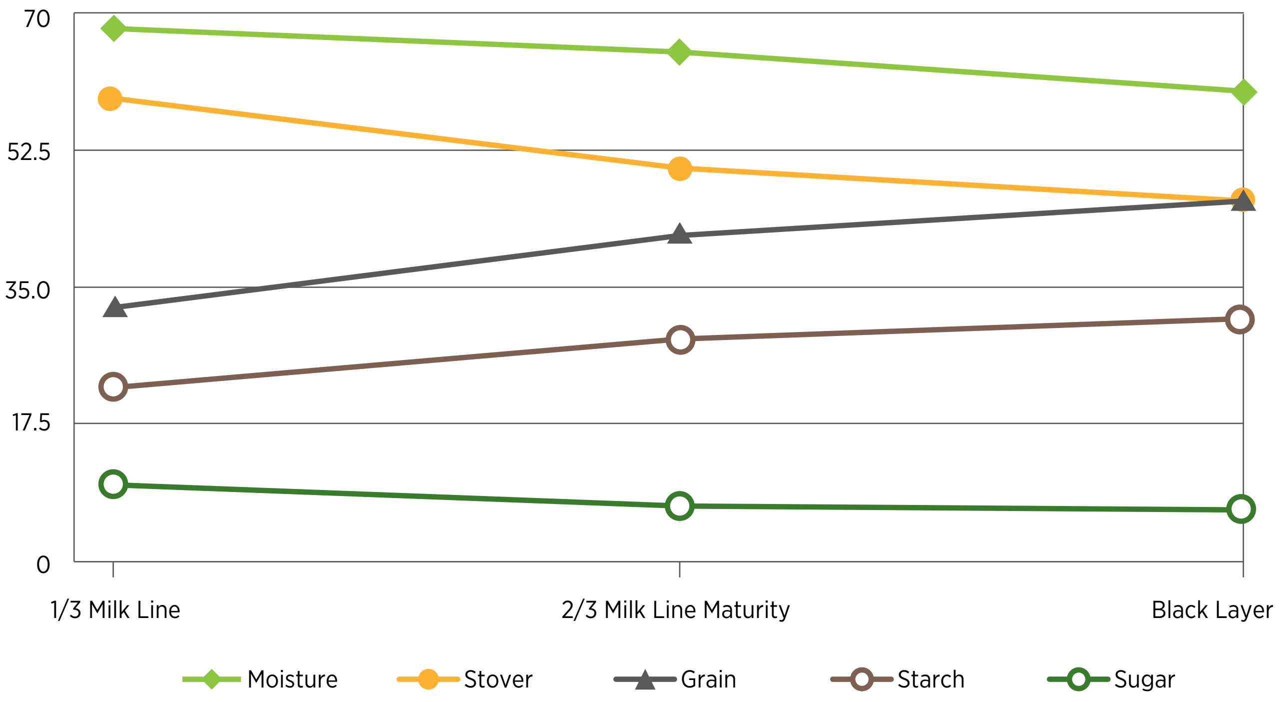
If you can wring water out of the material, you are almost certain to have run-off from your silage stack. Either increase the chop length or delay the harvest. On the other hand, if the maize silage does not stay compressed after squeezing, the maize is too dry. Chop length should be shortened.

Ensure your contractor runs a plant processor. As the kernels become more mature, they are more likely to pass through the cow undigested. Plant processing improves kernel starch digestibility by breaking the hard exterior of the kernel, increasing the surface area and allowing better access to the rumen microbes. Aim to have 99% of the kernels cut into quarters (with a minimum target of 80%).

ABSOLUTE LEVELS MAY BE DIFFERENT, BUT THE TRENDS ARE THE SAME

Starch increases significantly with advancing maturity from 1/3 milkline to black layer

Source: Pioneer Cornlage.



MAIZE SILAGE INOCULANT

Pioneer® brand maize silage inoculant adds significant value to your investment in maize silage.
Maize inoculants improve the fermentation, reducing losses, improving the performance from your silage when feed to stock. Pioneer® brand inoculants are unique because:

- Pioneer has a world-class inoculant research program with patented products. The bacteria used in Pioneer inoculants are only available from Pioneer.
- Pioneer conducts extensive research at our Livestock Nutrition Centre in the US.
- Pioneer produces crop specific inoculants for improved results.
- Pioneer is ISO 9002 accredited which is an external organisation that audits Pioneer's processors so what is claimed to be in the bottle is in the bottle. An inoculant company that you can trust.

Insist that Pioneer inoculant is applied to your maize silage.

STACK MANAGEMENT

Select a well drained site with good access for large machinery. Discuss with your contractor your planned site.

Good compaction is the key to making top quality silage. Take into account the rate at which the silage is being harvested when planning machinery requirements for compaction.

Compaction is a function of vehicle weight, rolling time and depth of spread of harvested material.

Remember that wheeled vehicles have a higher weight per surface area and achieve better compaction than tracked vehicles of an equal weight. If a small tractor, that you plan to use, has duals, remove the outside wheels, increase the tyre pressures and attach weights.

Fill the bunker or stack as quickly as possible to minimise exposure to the air. Where possible, fill in a wedge shape. This will give good compaction and minimise the amount of time that the maize silage is exposed to the air. Spread each load into a 100-150 mm layer so that it can be compacted properly. If large loads are being delivered to a stack site, dump the loads in front of the stack.

Build the stack by taking small loads to the stack, layering as you go to achieve the desired shaping.

After the last load has been delivered continue compacting until the surface of the stack or bunker is firm. Make sure stack sides are straight and parallel. Ensure that all loose material is removed from the sides and ends and is compacted on the top before covering. Limit the length of the "toes" at each end of the stack, leaving them as steep as possible taking safety considerations into account.

The stack or bunker should have a smooth surface. This allows the cover to be laid flat without creases or folds.

Cover the stack as soon as possible after compaction is completed. The quicker the environment of the stack becomes anaerobic after the sealing of the cover the lower the loss in feed value. Consider safety aspects (e.g. power lines, buildings etc) if attempting to place stack cover in windy conditions. Ensure enough staff are on hand, to keep control of the cover. Seal around the base of silage stacks by placing a layer of sand or lime. If the cover must be joined, ensure that joints are sealed well. Where possible, avoid a large overlap as condensation can form between the layers of plastic and drip into the silage causing spoilage. Weigh down your silage cover firmly with tyres that are touching or sand bags placed closely together.

Contact your local Pioneer Area Sales Manager or Promoter Agent if you need help assessing crops for harvest.

For further information contact Pioneer on 1800 PIONEER

TABLE: Pioneer Corn Silage Inoculants

	PIONEER® 11CFT	PIONEER® 11C33	PIONEER® 1174
Fully researched and proven	•	•	•
ISO 9002 accredited	•	•	•
Improved fermentation	•	•	•
Aerobic stability	•	•	
Improved fibre digestibility	•		

THE FIRST LOAD

Spreading loads

Fill the bunker or stack as quickly as possible to minimise exposure to the air. Where possible, fill in a wedge shape. This will give good compaction and minimise the amount of time that the maize silage is exposed to the air. Spread each load into a 150-200 mm layer so that it can be compacted properly. If large loads are being delivered to a stack site, dump the loads in front of the stack. Build the stack by taking small loads to the stack layering as you go to achieve the desired shaping.

Compaction

Continue compacting for up to two hours after the final load has arrived at the stack.

Straightening the stack

Make sure stack sides are straight and parallel. Ensure that all loose material is removed from the sides and ends and is compacted on the top before covering. This is best done by hand using a rake and/or a wide mouthed shovel. If the sides of the stack are not smooth, it will be difficult to lay the cover without creases and folds occurring.

Smoothing and covering

The stack or bunker should have a smooth surface. Remember to roll and compress any material that was moved by hand. The cover should be flat with no bumps or hollows so that the entire surface of the plastic is touching the silage material. Seal around the base of silage stacks by placing a layer of sand or lime on top of the cover. If the cover must be overlapped, ensure that the joins are sealed well. Where possible, avoid a large overlap as condensation can form between layers of plastic and run into the silage causing spoilage. Weigh down your silage cover firmly with tyres or sand bags placed closely together.

Feed-out management

Aim to keep the face of the maize silage stack tight throughout the feed-out period. You should not be able to push your fingers into the stack any further than the depth of your finger nails. Maize silage that is loose allows air to penetrate into the stack. Aerobic (oxygen-loving) bacteria break down plant material producing waste products including carbon dioxide, heat and water. Silage quantity and quality are decreased.

Maize silage that is well compacted and sealed will not contain moulds. Moulds grow once the silage has been exposed to the air for a few days or more. Although not all moulds are harmful, some can cause animal health problems and even death. Never feed mouldy or rotten silage to your animals.

HEATING AND THE SUBSEQUENT GROWTH OF MOULD WHEN SILAGE IS EXPOSED TO AIR CAN BE REDUCED BY USING A PIONEER® BRAND INOCULANT CONTAINING *L. BUCHNERI* SUCH AS 11C33. CONTACT YOUR LOCAL PIONEER AREA MANAGER FOR MORE INFORMATION.

A SLOW INTRODUCTION WILL ALLOW STARCH-DIGESTING BACTERIA LEVELS TO INCREASE AND WILL IMPROVE UTILISATION AND MINIMISE THE RISK OF GASTRIC DISTURBANCES. ANIMALS THAT HAVE NOT BEEN FED MAIZE SILAGE PREVIOUSLY MAY TAKE A FEW DAYS TO ACQUIRE A TASTE FOR IT.

Careful use of the tractor bucket at feed-out time will minimise loosening of silage. If possible, use the bucket to chip down silage then scoop it up from the ground. Avoid digging into the stack as this loosens silage that will not be fed for several days. The first step is to work out how far into the face you need to feed. Next, scoop out the lowest section of silage. Then using the bucket blade, chip down the silage one section at a time starting at the bottom.

Another alternative is to move sideways across the bunker face removing small amounts of silage from the whole face.

Silage grabs and block cutters will assist in keeping the face of the stack or bunker tight.

It is not necessary to lower the silage cover if maize is being fed on a daily basis since it will be impossible to seal the stack. The air that is trapped under the stack tends to heat creating an ideal environment for the growth of mould. Lowering the cover may be advisable during periods of heavy rain or if birds are a problem.

Starting to feed maize silage

Introduce maize silage into the diet over a period of 5-10 days. Start by allocating each animal 1-2 kg dry matter and increase the amount that you feed each day. The reasons for gradually introducing maize silage into the diet are numerous.

The rumen of a cow will contain cellulose-digesting and also starch-digesting bacteria. Most of the sugars in grass are stored as cellulose whereas the grain in maize silage contains high levels of starch. Animals that have been fed totally on grass will have relatively low levels of the starch-digesting and high levels of the cellulose-digesting bacteria. Feeding large amounts of maize silage to cattle that have low levels of starch-digesting bacteria will result in the inefficient use of the maize grain resulting in large amounts appearing in the dung. A slow introduction will allow starch-digesting bacteria levels to increase and will improve utilisation and minimise the risk of gastric disturbances.

Daily feeding

Once maize silage has been introduced to the diet, feed it on a daily basis. No feed will be efficiently used by an animal if it is being added to and removed from the diet at frequent intervals.

Do not feed maize silage in advance. The best time to fill your feedout wagon or bins is immediately prior to the time that you will feed the silage to your cows. Once silage is removed from the stack and loosened, aerobic (air present) spoilage begins.

Heating when silage is exposed to air can be reduced by using a Pioneer® brand inoculant containing L. buchneri such as 11C33.

Methods of feeding

Farmers are increasingly using feed pads for maize silage feeding. Where a feed pad is not available maize silage can be fed out using a feed-out wagon. The maize silage can be dumped in piles (by remaining stationary and allowing the silage to feed-out), in a line in the centre of the paddock or against a fence line.

The metabolisable energy content of maize silage is largely determined by the percentage of grain present since grain contains 70 percent more energy than stover (the green part of the plant).

Time of harvest, fermentation quality and feed-out management will also have an effect on energy content. Some well fermented, high grain content maize silages have metabolisable energy levels in excess of 11.5 MJME /kg DM, i.e. MJ of metabolisable energy per kg of dry matter.

CROP WET WEIGHT (TONNES)
X
DRY MATTER (PERCENT)
=
CROP DRY MATTER YIELD (TONNES)

BUYING IN MAIZE SILAGE

Purchase price

Maize silage is normally traded on a standing basis with the purchaser paying for the harvesting and all subsequent costs. There are two main methods of purchasing a standing crop.

1. On a per kilogram dry matter basis

In this case the grower and purchaser agree upon a standing price (cents per kg of dry matter). Legally, crops that are sold on a weight basis must be weighed on a 'weights and measures approved' weigh bridge. Every load of the crop must be weighed to determine the wet weight. Drymatter samples are collected throughout the harvest period and analysed to determine the dry matter percentage.

The advantage of buying a crop on a per kilogram dry matter basis is that you know exactly how much you will be paying for each kilogram of dry matter that you feed. The main disadvantage is that cartage costs may be increased if trucks need to detour to be weighed. Care must be taken to ensure that a representative dry matter sample is collected.

2. On a per hectare basis

The grower and purchaser agree upon a price per hectare prior to crop harvest time. The actual maize silage cost (cents per kg of dry matter) will vary greatly depending on the per hectare price paid and the crop yield.

When a crop is purchased on a per hectare basis, the purchaser gains the advantage of a high dry matter yield and the risk of a poor dry matter yield.

Selling on a per hectare basis means that there is no requirement to weigh the crop or to take dry matter samples to determine yield.

Subsequent costs

If a crop is purchased standing the grower is required to pay for further costs such as harvesting, inoculants, cartage, stacking and covering.

12 SUMMARY

THE INPUT MOST FREQUENTLY FOUND TO BE DEFICIENT IN LOW YIELDING OR UNPROFITABLE CORN CROPS IS GROWER MANAGEMENT. EVERY CORN GROWER MUST LEARN TO SET A YIELD GOAL AT THE START OF THE SEASON BEFORE HE BEGINS PLANTING.

Without a yield goal it is impossible to calculate the correct plant population needed, the amount of fertiliser required, or whether the intended crop will be profitable.

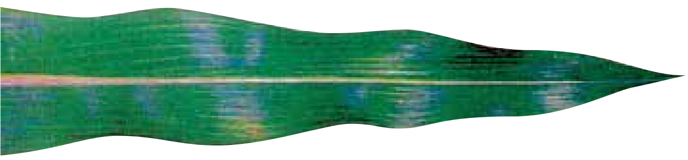
Corn is a crop that offers farmers the prospect of good profit margins provided they are prepared to –

1. Understand the requirements of the crop
2. Plant suitable hybrids at the correct plant population
3. Provide adequate fertiliser inputs
4. Supply the crop with water at the critical growth stages
5. Only grow a manageable area

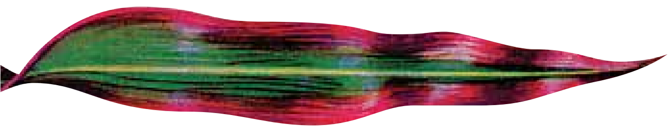
- Timeliness is an essential element of corn crop management, and most corn crop failures, can be traced back to poor timing of inputs or farming operations associated with that crop.
- Early preparation is another important element of successful corn crops, including ground preparation, fertiliser and water application to ensure yield is not lost.
- Early planting usually gives the highest yields in any area each year because of the longer growing period available to accumulate sugars and starches in early spring.
- A combination of early planting is almost always involved in all high-yielding crops produced by Australia's leading corn growers.
- Corn is a crop that responds to good management, so time and effort spent learning how to grow and manage the crop will result in improved yields and profitability.

Pioneer Australia hopes that the information in this booklet will assist our customers in becoming better and more profitable corn growers.

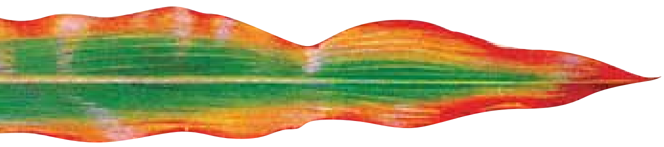
13 GUIDE TO NUTRIENT DEFICIENCY SYMPTOMS



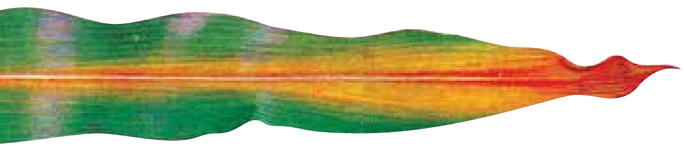
Healthy leaves shine with a rich dark green colour when adequately fed.



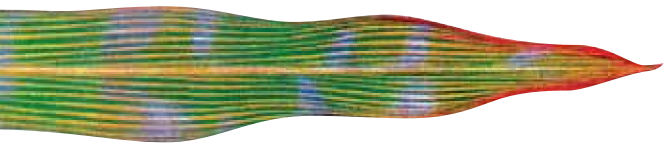
Phosphate shortage marks leaves with reddish-purple, particularly on young plants.



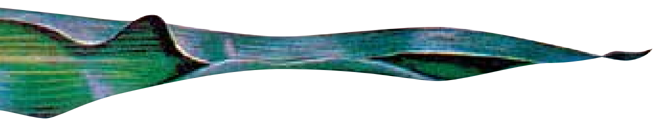
Potash deficiency appears as a firing or drying aong the tips and edges of lowest leaves.



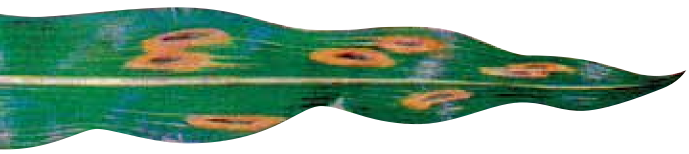
Nitrogen hunger sign is yellowing that starts at tip and moves along middle of leaf.



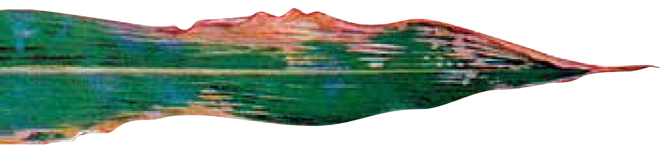
Magnesium deficiency causes whitish strips along the veins and often a purplish colour on the underside of the lower leaves.



Drought causes the corn to have a greyish-green colour and the leaves roll up nearly to the size of a pencil.



Disease helminthosporium blight, starts in small spots, gradually spreads across leaf.



Chemicals may sometimes burn tips edges of leaves and at other contracts. Tissue dies, leaf becomes whitecap.

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