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Introduction
Seed Co is committed to enhancing the productivity of farmers. This is primarily achieved through the provision of quality seed of the best food crop varieties suited to each agro-ecological environment of Zimbabwe. However, the right crop variety and certified seed are only two parts of the farmer's strategy to be productive and profitable. Good Agronomic Practices (GAPs) plays a crucial role in achieving high and economically sustainable yields. A productive farmer has to combine variety choice, the environment with GAPs to be successful. This manual provides some basic information that will help farmers produce maize, soyabean, groundnuts, sorghum, cowpea and wheat efficiently, profitably and sustainably.

MATTER OF FACT: There are a thousand reasons for low yields, but only two good reasons for high yields – USING SEED CO SEED AND GOOD AGRONOMIC PRACTICES!

The Basics of Productive Crop Farming
In order for crops to be healthy and productive they need the following:

1. Soil
Soil is one of the most basic resources required for crop production. It is the medium where crops grow. It is made up of very small rock particles, organic matter, micro-organisms, air and water, and the proportions of these and many other related factors have an impact on the potential for crop production. The two basic universal limiting factors of soil for crop production are:

- the ability to supply nutrients, and
- the supply of water.

Other soil factors that affect crop productivity include:

- Adverse chemical conditions, such as soil acidity, alkalinity, salinity and toxic chemicals.
- Lack of aeration, particularly in wet years and in waterlogged soils.
- Erosion, which removes the topsoil and washes away nutrients.
- Physical limitations, such as shallow soil, rocks, gravel, hard sub-soil layers and surface crusts.

NB: Soil acidity must be corrected promptly by liming. We will give an addendum on issues to do with soil conditioning in later sections.

Soil conditions that favour crop growth include:

- Fertility, including the soil reaction (i.e., the acidity or alkalinity). Fertile soils that are slightly acid to neutral are best for most crops, while saline soils are adverse for most crops. Soil management follows this adage, "Productive soils are always fertile, but fertile soils are not always productive."
- Depth and drainage: Deeper and well drained soils are better than shallow soils, simply because they store more water and allow water movement.
- Texture and structure: These refer to the amount of clay in a soil and the way the soil particles bind together. Soils with some clay tend to be better than pure sands, while soils with a good structure are stable, resist erosion and are good for crop production.
2. Water
All crops need water, which must be supplied to the soil either by rain, irrigation or both. The key for good crop growth is to have a balance between too little water and too much water, as either case may adversely affect crop productivity. Over-supply and under-supply of water all have negative implications on crop growth. The best situation is where there is sufficient water to meet the needs of the crop during the various stages of its growth, therefore it is not just the total amount of rainfall or irrigation but the distribution that is important for good growth. In regions where rainfall or water supply is insufficient, conservation of rainfall and reduction of run-off is important.

3. Nutrients
Crops need 16 chemical elements for growth and reproduction, but not all in the same quantities. Carbon, oxygen and hydrogen are obtained from the air and water, and are used in very large quantities. The remaining thirteen are obtained from the soil, of which two, nitrogen and phosphorous, are generally deficient in most African soils and have to be supplied in their large quantities. Many nutrients are only required in very small amounts, but a lack of them may severely limit crop growth and reduce yields. See section for simple symptoms of micro-nutrient deficiency.

4. Sunlight, air and temperature
The sun provides the energy needed for plant growth. The air supplies essential gases used by plants, while the temperature of the air and soil affects the rate of plant growth processes. Sunlight, air and warm air temperatures are factors which farmers rarely need to worry about in Africa. However, at times in summer, cloudy, overcast, cool conditions may slow down plant growth, while strong winds may cause plants to fall over (called *lodging*). Some areas are also very hot and dry, which may adversely affect crop growth. Thus, it is important to time the production of a crop in a period of the year that is best suited to maximise yield potential.

5. Good Agronomic Practices (GAPs)
This is the often forgotten or neglected ingredient for good crop production. Farmers must recognise that there are some factors within their control which directly reduce crop yields, such as weeds, pests and diseases, and others which may add to yield potential, such as fertilisation, plant spacing, timing of planting, land preparations, variety selection and water conservation measures. Management requires that the farmer does everything to promote those factors that enhance crop production and as much as necessary to minimise those factors that reduce crop production, while at the same time ensuring profitability. Many times farmers blame other factors for failed crop production, when in fact their own management might be lacking.

The main factors that reduce yields are:

- **Weeds**
  Weeds compete with crops for sunlight, water and nutrients. Crop yields are most adversely affected by weed competition during the first four weeks after crop emergence. Weeds may also interfere with other activities like spraying and harvesting.

- **Pests and diseases**
  Low levels of pests and diseases may be of little concern, but when they increase above certain limits (called Economic Threshold Levels-ETLs), then they must be controlled otherwise yield reduction and economic losses may occur. In many cases, especially with diseases, the pre-disposing factors of the problem must also be determined and dealt with if the problem is to be overcome sustainably. When chemical sprays are used, safety precautions and correct application techniques must be followed. More detailed discussion of particular pests and diseases are given in the crop production sections.
1. APPLICATION OF FERTILISER AND MANURE

Fertiliser and manure must be applied taking into consideration the soil's ability to supply nutrients, the requirements of the intended crop (i.e., the yield targets) and the economics of fertiliser application. Wherever possible, organic manure can be a good source of nutrients for crops, because they are essentially free and contribute much to soil sustainability. Bought inorganic fertilisers are very essential supplement of nutrients for the soil. The amount and type of inorganic fertiliser to apply depends on:

- The nutrient supplying ability of the soil. Soils that are infertile or where no manure is applied will require more fertiliser than fertile soil or when manure is applied. Fertilisers should supply those nutrients that are most limiting.
- The expected yield from the crop. Higher expected yields demand more nutrients, and therefore more fertiliser. But, more fertiliser will not always give higher yields. Crop fertilisation should be in accordance to the soil and the yield potential, which in turn is related to the environment and management ability of the farmer.
- Economics. Fertilisers cost money, and therefore the farmer must be sure of obtaining a profitable return on the cost of fertiliser if he is to stay in business. Nevertheless, in well-managed fields the consequence of over-fertilising is generally less costly than under-fertilising, because it builds up the fertility status of the soil.

**NUTRIENT REMOVAL (kg per tonne of grain and stover)**

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Maize</th>
<th>Soyabeen</th>
<th>Groundnuts</th>
<th>Wheat</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grain</td>
<td>Stover</td>
<td>Grain</td>
<td>Stover</td>
</tr>
<tr>
<td>N (Nitrogen)</td>
<td>13</td>
<td>10</td>
<td>65</td>
<td>16</td>
</tr>
<tr>
<td>P2O5 (Phosphorus)</td>
<td>5.8</td>
<td>4.5</td>
<td>15.0</td>
<td>3.0</td>
</tr>
<tr>
<td>K2O (Potassium)</td>
<td>4.2</td>
<td>16.0</td>
<td>22.0</td>
<td>13.0</td>
</tr>
<tr>
<td>Ca (Calcium)</td>
<td>1.1</td>
<td>2.4</td>
<td>28</td>
<td>25</td>
</tr>
<tr>
<td>Mg (Magnesium)</td>
<td>0.88</td>
<td>1.85</td>
<td>7.8</td>
<td>8.4</td>
</tr>
<tr>
<td>S (Sulphur)</td>
<td>1.5</td>
<td>1.0</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Zn (Zinc)</td>
<td>22g</td>
<td>20g</td>
<td>24g</td>
<td>18g</td>
</tr>
</tbody>
</table>

**Checkerlist before applying fertilizers:**
- Are other agronomic factors (variety, plant protection, water, etc.) satisfactory?
Are basic requirements of soil fertility fulfilled? (pH, organic matter, stable porous soil structure, absence of compacted layer, good drainage, no salinity).

Which nutrients need not be considered in this particular soil? (Many soils have adequate Ca, Fe, Mo, etc.).

Which nutrients need not be considered every year? (e.g. Mg may be supplied in liming material, Zn, B and Cu in long-lasting, slow-acting fertilisers.)

What amounts of fertiliser Phosphorus and K (Potassium) are needed at sowing time? (To be determined by soil testing or, in well supplied soils, estimated from nutrients removal by crop).

What kind and amount of N fertiliser is needed, and when? (Either based on expected yield or soil testing).

Which nutrients may have special problems in this soil (e.g. fixation of Mn) or are needed in large amounts by particular plant species (e.g. S for oilseed rape, B for beet and legumes)?

What is the best way of applying fertiliser? (Banding in crops such as maize is usually more efficient than broadcasting, depth and placement of fertiliser should relate to root structure. Broadcasting is more efficient on other crops such as soyabean, sugarbean, sorghum.)

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Deficiency</th>
<th>Nutrient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptoms appearing first on younger leaves:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mottled yellow-green leaves with yellowish veins</td>
<td>S</td>
<td>Sulphur</td>
</tr>
<tr>
<td>Mottled yellow-green leaves with green veins</td>
<td>Fe</td>
<td>Iron</td>
</tr>
<tr>
<td>Brownish black spots (e.g. on legumes, potatoes)</td>
<td>Mn</td>
<td>Manganese</td>
</tr>
<tr>
<td>Youngest leaf has white tip</td>
<td>Cu</td>
<td>Copper</td>
</tr>
<tr>
<td>Youngest leaf is brownish or dead (e.g. on beet)</td>
<td>B</td>
<td>Boron</td>
</tr>
<tr>
<td>Broad bands of bleached, pale tissue</td>
<td>Zn</td>
<td>Zinc</td>
</tr>
<tr>
<td>Symptoms appearing first on older leaves:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chlorosis (i.e. yellowing of leaf) starting from leaf tips</td>
<td>N</td>
<td>Nitrogen</td>
</tr>
<tr>
<td>Necrosis (i.e. death) on leaf margins</td>
<td>K</td>
<td>Potassium</td>
</tr>
<tr>
<td>Chlorosis mainly between veins (which remain green)</td>
<td>Mg</td>
<td>Magnesium</td>
</tr>
<tr>
<td>Brownish, greyish, whitish spots (e.g. on cereals)</td>
<td>Mn</td>
<td>Managnese</td>
</tr>
<tr>
<td>Reddish colour on green leaves or stem</td>
<td>P</td>
<td>Phosphorus</td>
</tr>
</tbody>
</table>

Addendum 1: Soil Conditioning and Liming-The secret to improving crop productivity
Soil pH is an excellent chemical indicator of soil condition (quality and its ability to avail nutrients (both macro and micro)) to the crop on top of other soil structural quality properties.

Why is soil sampling and analysis important?
Firstly farmers MUST sample their soils for pH and fertility analysis. If there are any imbalances in the soil pH and fertility, they must be corrected promptly e.g. low pH is corrected by liming. Use of appropriate liming agents (dolomitic or calcitic lime) is recommended as this enhances Fertilizer Use Efficiency (FUE). Agricultural lime is a relatively cheap soil conditioner whose many benefits to the farmer far outweigh the cost of procuring and applying it. Hence the continuous and consistent use of lime will enhance the profitability of any cropping concern. This is the top secret to enhancing yield per unit area it is our strong feeling that it must be promoted and encouraged to farmers. Some would even argue for the legitimation of this critical aspect.
Secondly application of fertilizers is heavily recommended if we are to get good crop productivity levels and returns on investment. The principle is to apply the right quantities of the right type of fertilizer at the right time and place. Fertilizer regime management should follow prescriptions from the soil analysis recommendations.

It is important to sample your soils for analysis after every 3-4 years depending on soil type. We recommend 3 years for lighter soils and 4 for heavier soils. In a season the best time to sample soils is the first week after harvesting a summer crop. This will give the farmer a good lead time to correct any deficiencies in the soil, 3-6 months before establishing the next crop in summer. Farmers should note that lime can be applied even on the day of planting and still act as a “buffer” before correcting the soil acidity condition but the ideal/optimum time to apply is at least three months before planting the next crop.

**How important is pH on NPK uptake?**

For more appreciation on the importance of pH on crop development, farmers should refer to the following table showing NPK uptake efficiency vs pH levels: This is critical information.

<table>
<thead>
<tr>
<th>pH level</th>
<th>4.5</th>
<th>5.0</th>
<th>5.5</th>
<th>6.0</th>
<th>6.5</th>
<th>6.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>30%</td>
<td>43%</td>
<td>77%</td>
<td>89%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>23%</td>
<td>31%</td>
<td>48%</td>
<td>52%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Potassium</td>
<td>33%</td>
<td>52%</td>
<td>77%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

**Key:**
- Low pH, low NPK uptake efficiency, lime is recommended
- Optimum pH (6.5-6.8), high NPK uptake efficiency

**How to sample soils?**

The most commonly used procedure for soil sampling would be based on soil type. Fields are split into sampling blocks that contain similar soils e.g. block A, B, C and so on. Hillsides are kept separate from bottoms since the soil types will vary greatly. Soil survey maps, if applicable, can help organize the soil types throughout the sampling area. Samples will not necessarily need to be collected for every soil type; however, similar soils should be kept together. The zig zag, random, the cross diagonal methods are commonly used and recommended where samples are taken in a zig zag or at cross diagonal format from a block. This will result in a sample which scientifically represents the whole block.

Once the sampling block is determined, a sufficient number of sites/cores should be taken to acquire a representative sample. This is generally 10 to 20 sites. The depth of sample for surface soils would be about 20cm or as deep as the primary tillage or specifically as deep as the root zone of intended crop(s). This is also called the tillage layer. The most commonly used tools for taking samples are augers, probes, hoes or sometimes shovels. Samples from different sites in a block are then mixed thoroughly and bagged into a khaki pockets and labeled. Information on the labels should include farmer name, farm name, contact details, block name, date taken and intended crop before they are submitted for analysis to approved laboratories.
When to sample soils?

Winter is the ideal time for soil sampling except for testing for nitrate-nitrogen in sandy soils. Winter sampling allows more time to get the results from the testing laboratory and avoids the busy laboratory schedule in the spring. Getting results on time will also allow time for actioning of the recommendations e.g. if lime is to be applied then the best time is 3 – 6 months before crop establishment. Mid or late summer is the appropriate time to collect soil samples for winter wheat. Phosphorus level in the soil should be determined prior to seeding winter wheat. Nitrate-nitrogen tests made prior to planting winter wheat help predict nitrogen fertilizer needs for the crop.

Where are the Laboratories?

Most fertilizer houses do sampling free of charge or for a small amount. Other approved laboratories include the Department of Specialist Services-Soil Chemistry laboratories. Other recognized laboratories include Soil Testing Laboratory at the University of Zimbabwe’s Soil Science Department; Tobacco Research Board, AgLabs, Africa University etc. Always prescribe the intended tests before submission. We strongly recommend farmers to do a full analysis (pH and soil nutrient profiling).

Soil analysis results normally come with recommendations. We recommend farmers to understand the recommendations from the laboratory tests and also to seek technical guidance in the interpretation of results from Agritex extension personnel in their respective holding areas. Seed Co Agronomy Services also assist in interpreting results from laboratories. Contact a Seed Co Agronomist in your province.

What are Acid Soils?

These are soils with a pH measure of less than 7 on a Calcium Chloride Scale in Zimbabwe. These soils contain high levels of active hydrogen and or aluminum in relation to calcium and magnesium levels. Farmers can improve the soil quality of acid soils by liming to adjust pH to the levels needed by the crop to be grown.

Soil pH is the measure of the acidity or alkalinity of the soil. The degree of acidity or alkalinity is determined by measuring the concentration of the hydrogen ions in the soil solution. This is expressed in terms of a scale with a range of 0 to 14. A soil with a pH of 7 is considered neutral while less than 6 is considered acid and a soil with pH greater than 7 is considered alkaline. A good liming program is based on soil test that determines the degree of soil acidity and the correct amount of a liming material needed to neutralize that acidity. Once this amount is determined, a liming material must be selected that will economically satisfy the soil test recommendation and result in maximum and efficient crop productivity levels.

What cause soils to be acidic?

There are basically three causes of soil acidity:

- Soils may become more acid as a result harvested crops removing bases such calcium and magnesium from the soil. This is a normal and natural process. Different crops remove different amounts of Calcium and Magnesium from the soil.

- Rainfall also affects soil pH, whereby water passing through the soil leaches basic nutrients such as Calcium and Magnesium beyond the root
zone into drainage water replacing them with acidic elements such as Hydrogen, Manganese and Aluminum and thereby acidifying the soil.

- Application of nitrogen fertilizers e.g. Ammonium Nitrate or Urea and to a lesser extend though basal fertilisers, contribute to soil acidity by nitrification of ammonium to nitrate a process which releases hydrogen ions. Organic matter breaks down naturally in soil and hydrogen ions are released, which causes an increase in soil acidity. Plants release hydrogen ions to the soil which contributes to the soil acidity.

**Why does soil acidity matter to crop productivity?**

- **Toxicity to crop**: as the pH decreases below 5.5, the availability of aluminum and manganese increase and may reach a point of toxicity to the plant. Excess Aluminum ions in the soil solution interferes with root growth and function, as well as restricting plant uptake of certain nutrients.

- **Effect on phosphorus availability**: acid soils cause Phosphorus to form insoluble compounds with aluminum and iron. Liming of soils with low pH dissolves these insoluble compounds and allows Phosphorus to be more available for plant uptake.

- **Micronutrient availability**: acidic soils affect the availability of micronutrients in the soil and affects general crop development and productivity ultimately.

- **Soil organisms**: some micro-organisms e.g. important bacteria and fungi in the soil associated with nitrification require a certain soil pH level to function efficiently. In other words the beneficial microorganisms do not function efficiently in acidic soils (low pH).

- **Soil physical condition**: liming improve soil physical structure by reducing soil crusting/capping and this promotes better emergence of small-seeded crops and ultimately result in better crop stands. Remember population stand is key in attaining higher yields generally in all crops.

**When is the right time to lime?**

Lime should be applied at least 3 to 6 months before crop establishment since it takes a significant amount of time for lime to dissolve and react with the soil to cause the desired adjustments in pH. In other words a week after harvesting is the best time to apply lime. However farmers should note that, application of lime can still be done even during crop establishment and the lime can act as a ‘buffer’ which acts as a conduit for nutrient uptake from soil to crop through the roots and adjust the pH during the later stages of the crop cycle. Frequency of subsequent liming should be determined by soil tests.

**Lime placement and incorporation**

The most important factor determining the effectiveness of lime is placement and incorporation. Placement for maximum contact with the soil into the root zone of the intended crop/tillage layer is essential and must be achieved. We generally recommend lime to be applied in the 15-25cm zone as this is a root zone range of most food crops grown in Zimbabwe e.g. the staple crop—maize. For maximum effectiveness, lime should be uniformly spread and incorporated into and with the soil. Incorporation can be achieved through discing or harrowing followed concurrently by a roller. In Zimbabwe liming agents are in powdery formulations to increase surface area for quicker reaction with the soils.

Lime can be spread by hand or by lime spreaders—which normally gives the best results. Hand application is normally not recommended when the weather is windy. However, I have seen some smallholder farmers mixing lime with a basal fertilizer before application and giving commendable results. However my only
concern with this method is on the timing of lime applications (basal fertilizers are normally applied during planting and yet we recommend lime to be applied 3-6 months before crop establishment). But still act as a buffer.

**What amounts of lime can one apply?**

We recommend farmers to follow recommendations on the soil analysis results with regards to amounts and type of lime to be applied. The amount is depended on the acidity levels of the soil and differs from one soil type to another. However the following general recommendation can be useful and is depended on the soil type.

Amount of lime required to raise soil pH by 0.1 units for different soil types-a gentle guide:

<table>
<thead>
<tr>
<th>Soil type</th>
<th>Lime rates to raise by 0.1 pH units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandy soils</td>
<td>100kg/0.1 pH units</td>
</tr>
<tr>
<td>Sandy Loamy soils</td>
<td>120kg/0.1 pH units</td>
</tr>
<tr>
<td>Clay soils</td>
<td>200kg/0.1 pH units</td>
</tr>
</tbody>
</table>

*General interpretation: it means a farmer with a sandy soil requires 1000kg (1 tone) of lime to raise his pH from 4.5 (acidic) to 5.5.*

**What is maintenance liming?**

The use of Nitrogen containing fertilizers increases soil acidity levels. So we generally recommend that whenever any form of Nitrogen, be it from basal (compound D, L, S or J, blends and high analysis blends etc.) OR top dressing (e.g. AN/Urea) is applied, a farmer needs a maintenance lime application of about 1.8kg for every 1kg of Nitrogen applied. This is applicable if one does not carry out a soil analysis before the next crop. However the top recommendation is to sample your soils for analysis to determine lime rates and type after at least every 3 or 4 years of soil use.

**What are the liming agents available in Zimbabwe?**

It is important to sample your soils for analysis to determine pH and also the liming agent to be used. We strongly discourage farmers to blindly apply lime without qualification of the liming agent from soil analysis results. This can result in some detrimental effects to the soil and crop productivity. It can result in what we call preferential uptake. In Zimbabwe we basically have two types of liming agents i.e. Dolomitic Lime (Magnesium Carbonate) which is ideal for adjusting pH in magnesium deficient soils. The other agent available in Zimbabwe is Calcitic Lime (Calcium Carbonate) which is suited for adjusting pH in calcium deficient soils. There is no blanket recommendation for a liming agent and hence this should be noted. Preferential uptake is when a certain nutrient is taken up at the expense of the other or a balanced uptake due to concentration differences. A good example is when Calcitic lime is applied (blindly) instead of Dolomitic lime- this will cause an increased uptake of Calcium at the expense of a balanced uptake with other elements e.g. Magnesium, and therefore a crop will show magnesium deficiencies—yield will be affected.

**Lime vs Gypsum**

This is a frequently asked comparison. Lime (Calcium Carbonate/ Magnesium Carbonate) adjust soil pH and at the same time supply the soil with either Calcium or Magnesium and Carbon, depending on the liming agent used. Lime ‘sweetens’ acidic soils. On the other hand Gypsum (Calcium Sulphate) is a supplementary source of Calcium and Sulphur which farmers apply whenever there is deficiency of these 2 elements in the soil. It should be noted that Gypsum **does not adjust soil pH** but rather **supplement the soil with Calcium and Sulphur**. Gypsum also improves soils physical structure i.e. removes hard setting clodiness, removes surface crusting/capping and improves soil workability.
What are the benefits of liming?

- Liming generally improves soil structure and nutrient availability in the soil and ultimately crop productivity and to a greater extent improves livelihoods and the economy at large. Liming also provides some plant nutrient such as Calcium or Magnesium and Carbon. My favorite term for these is ‘complimentary benefits’.

- Liming improves Fertilizer Use Efficiency (FUE) by crops. Use of fertilizer alone without lime result in poor fertilizer uptake and reduce the economic benefit of using fertilizer. In economic terms, lime is an enabler to get the best ROI on fertilizers. See table on NPK uptake efficiency

- Lime reduces availability of toxic elements in the soil such as aluminum and manganese. This result in improved root development and ultimately nutrient uptake.

- Liming improves the soil physical structure, resulting in good crop emergence and stand, greater root proliferation and an improved nutrient uptake.

- Liming acid soils improves the environment for beneficial soil microorganisms. In simpler terms it liming acidic soils to optimal levels creates a conducive environment for microorganisms to carry out necessary processes in the soil eg nitrification. A good example we always mention to farmers is of a soyabean crop. For the rhizobium (inoculant) to function properly (trap atmospheric nitrogen and fix into usable nitrate-process widely known as nitrogen fixation), there must be a conducive pH range of 5.2 to 6. That is why soyabean and most other legumes and food crops are sensitive to low soil pH. So generally liming will increase crop productivity in all crops (food, plantations and cash crops).

- Liming promotes a more rapid breakdown of organic materials in the soil, realizing nutrients for growing plants.

- Liming improves the palatability of forages.

- Some herbicides and soil based chemicals will not work properly in low pH soils, hence liming soils will enhance the efficacy of some herbicides especially pre-emergent herbicides.

2. PLANTING AND PLANTING TIME

The planting operation is one of the most important in crop farming because it is the time when the seed or seedlings are placed in the ground to establish the crop. If there is poor establishment, yield potential is immediately limited. Factors to consider are the time of planting, the plant spacing, the depth of seeding and placement of the seeds relative to fertilizer.

- The time of planting has a major effect on the yield of a crop. For most crops there is an optimum time of planting, which depends on the climatic conditions and the time taken to reach maturity. For summer crops, such as maize, cotton and groundnuts, early planting at the beginning of the rainy season is desirable, as yields decrease with late planting.

- The plant spacing refers to the distance between rows and between plants in the row. The closer the spacing, the greater the number of plants per hectare. The ideal plant spacing depends on the type of crop, variety and the climatic conditions such as rainfall/water availability. Short statured crops (like soyabeans) may be grown at closer spacings than tall, large crops (like maize). In drier areas, wider spacings are preferable in order to provide more soil water to the individual plants. In high rainfall areas, or where there is irrigation, closer spacings are possible.
The sowing depth of a crop depends on the size of the seed, the type of soil and the weather. Generally, smaller seeds are sown at a shallower depth than larger seed, while the deeper the seed is planted, the longer will the seedling take to emerge and the weaker will the plant be at emergence, which may reduce plant vigour and yield. Seed may be planted deeper into sandy soil or when dry planting (i.e., planting before the rain). An important point to remember when planting is to ensure good seed-to-soil contact, as this enables the necessary imbibition of water which initiates germination.

Allow for soil temperatures with dry planting. Seed is a living organism that can desiccate and die. Plant seed at least 2 centimeters away from applied fertilizers as the fertilizers can burn the seed.

3. VARIETY SELECTION
For most crops there are a number of varieties available. These are often appropriate for certain conditions, such as dryland or irrigated, and short season or long season production. The Seed Co Seed Product Manual and the Crop Sections in this Booklet provide more information. It is advisable not to rely on only one variety, but instead to grow a selection of the best varieties suitable to the farm's conditions. The use of certified seed also ensures that the seed is of the highest quality in terms of genetic purity, germination and viability/vigour.

Factors which affect varietal choice:
- amount and distribution of rainfall in one's area
- length of the growing season
- altitude and air temperature
- soil fertility and fertiliser application
- planting date
- desired plant density/population
- occurrence of pests and diseases
- general management

4. SOIL AND WATER CONSERVATION PRACTICES
Soil is the medium for crop production, while rainfall is one of the most limiting factors. Therefore, farmers ought to make every effort at conserving these two resources. This may be done using such techniques as zero-tillage, ridge-tillage, tied-ridges, pot holing, contour planting, strip-cropping, agroforestry or minimum tillage.

Yield targets
Yield targets for each crop should be set to give a goal to work towards. At the end of the season, it is useful to determine whether the target was achieved, and if not, establish the reasons in order for improvements to be made. The aim should be to increase yields each year. Some yield targets for field crops are as follows:

<table>
<thead>
<tr>
<th>Crop</th>
<th>Environmental potential</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Maize</td>
<td>3 t/ha</td>
</tr>
<tr>
<td>Soyabean</td>
<td>1.5 t/ha</td>
</tr>
<tr>
<td>Groundnuts (short)</td>
<td>1.0 t/ha</td>
</tr>
</tbody>
</table>
Groundnuts (long season, unshelled) | 2.0 t/ha | 3.5 t/ha | 5.0 t/ha
---|---|---|---
Sorghum (White) | 0.7 t/ha | 2.0 t/ha | >5.0 t/ha
Sorghum (Red) | 2.0 t/ha | 4.0 t/ha | >5.0 t/ha

NB: It is critical to benchmark one’s yields against the leading farmer’s yields in one’s area.

**MATTER OF FACT:** Higher yields are closely related to higher profits. Higher yields lower unit production costs and increase profits per ha. Always aim for higher yields each cropping season.

**LAND PREPARATION**

Land preparation is the process of preparing fields so that they may be planted to a crop. The objective is to create a seedbed with a fine tilth to enable crop establishment.

However, this objective must be achieved with
1. Minimum use of energy,
2. Minimum damage to the soil, and
3. Maximum conservation of soil and water.

The land preparation methods will vary with crop, soil type, field conditions, tools available and the farmer’s overall objective, but will generally involve some measure of soil disturbance, called tillage. The optimum amount of tillage may be defined as that which maximises the return from the crop planted. The more tillage that is applied, the more it will cost, the more energy it will take, the more it will damage the soil and the more water will be lost from the soil through evaporation. Consequently, farmers need to consider ways of effectively reducing the amount of tillage. Not only does this save on cost and energy, but it is usually better for the soil and helps to conserve soil and water, especially if there are residues remaining on the soil surface.

A traditional form of land preparation in Africa is ploughing. This is a system that inverts the soil, buries residues and pulverises the soil structure, leaving the soil exposed to erosion. The amount of soil, nutrients and water lost from ploughed fields by erosion is great, and therefore it is an unsustainable method of land preparation and is leading to the degradation of many farms. Furthermore, continuous shallow ploughing on sandy soils leads to an increase in acidity, a decrease in magnesium and results in poor yields.

Nevertheless, there are certain conditions under which ploughing may be warranted. For example, ploughing may be necessary to incorporate lime, or there may be a case for ploughing where the crop seed requires a fine seedbed. Where ploughing is necessary, it should be deep and preferably done in the winter season. However, for most field crops, ploughing should be considered the exception and not the rule. If a field is to be ploughed it must be for a very good reason, and only if no other better options are available.

Much better alternatives to ploughing exist, and these are generally termed **conservation tillage systems.** The aim with these is to carry out tillage only to the extent that is needed to produce a crop and with the primary aim of conserving soil and water. This is essential in parts of Africa because water is generally the most limiting factor, while the soil is the fundamental resource for all farming activities and must be conserved. One of the keys to conservation
tillage is the maintenance of surface residues on the field to at least 30% soil cover. The major benefits of conservation tillage include:

- Reduced soil erosion. The residues on the soil surface serve to "cushion" the rainfall impact and slow the runoff of water (and soil) from the field.
- Improve infiltration of water into the soil and reduce evaporation of water from the soil surface.
- Moderates the extremes of soil temperature. This is especially important in October and November when soil temperatures may be very high in the southern hemisphere countries.
- Improve soil structure. By minimising soil disturbance, the soil is given an opportunity to consolidate, roots are able to bind the soil together, the organic matter in the soil increases and soil organisms are able to flourish.
- Improved timeliness of operations. Tillage takes time and energy. Reducing tillage saves time and energy and therefore gives more opportunities to carry out other essential operations.
- Reduced costs. Conventional tillage generally contributes 15 to 20% of the total cost structure and adopting conservational tillage methods will reduce this cost driver significantly.
- Weed suppression. Residues on the soil surface smoother weeds and reduce weed pressure.

Conservation tillage include

**Tied Ridging.** This involves either planting the crop in small furrows, on the flat and making ridges during crop development, or planting the crop on prepared ridges, and then blocking the furrows at regular intervals. These "ties" act as mini-dams, which collect the rainwater and minimise the flow of water off the field. They are effective in both a wet and dry season. In a wet season, the crop is elevated on the ridge and suffers less from water-logging. In a dry season, the trapping of rainfall and conserving it in the field enhances yield.

Tied ridging requires much draught power and labour, but it is possible to have a permanent ridge system, which is simply maintained from year to year. Permanent ridge tillage controls the traffic in the field and leaves a compaction-free zone under each ridge. There is also available appropriate machinery, both for animal draught and tractor draught to manage ridge tillage and tied ridging systems.

Some of the problems related to tied ridging include:

- Poor germination of seed on ridges. This may be overcome by timely planting when ridges are wet, or by making an "M" shaped ridge or cup-shaped seed-planting hole to capture rain water.
- Weeding by hand may be difficult, but the key is early weeding, before weeds get too big. Alternatively, the ridges may be re-made when the crop is young, primarily as a weeding operation. Thereafter the furrows may be closed mechanically or by hand hoes.
- Lack of implements. The normal ox-drawn plough may be used for ridging, or a simple disc tie ridger adapted to the plough beam may be made.
- Ridges get destroyed in winter by cattle. This is true to some extent, especially on very weak sands, but generally, the ridges are still visible by the end of winter and provide a guide for re-ridging.
**Rip-on-row** (also known as Mulch ripping). This involves ripping lines with a tined implement along the intended planting row, following the contour line. Planting stations are marked out along the row with a hoe ready for hand planting, or the seed is sown directly into the furrow by hand or with a machine planter and then covered. The advantage of rip-on-row is that it is quick, requires less draught power than ploughing or tied-ridging and helps to maintain surface residues. It is useful where soils have a hard top-soil or surface crust, and/or where crops like soyabeans, dry beans or groundnuts are to be grown. Ripper tines are available which fit onto the ox-plough beam after removal of the mouldboard. This system is effective for soil water conservation in semi-arid areas, and reduces rainfall run-off in high rainfall areas.

**Wet ripping**
This is when ripper tines are passed through the interrow space during crop development (especially before 4 Weeks After Crop Emergence-WACE in maize).

**Zero-tillage** involves sowing the crop directly into an untilled soil. Planting stations are made with hoes, or the seed is sown with a specially made machine planter. The great benefits of zero-tillage are that it does not require draught power, while soil and water are conserved, and yields may be stabilised or enhanced. The labour requirements of zero-till are no more than any other system, if well managed. Two key factors for successful zero-tillage are the maintenance of at least 30 % residue cover and good weed control. In order to achieve this a farmer must:

- be prepared to control the extent of residue removal from fields. It is better to leave crop residues on the land
- learn the system - begin small, learn how to deal with problems and expand progressively as experience is gained, and
- control weeds throughout the year. Late weed control and winter weed control is essential and beneficial. The use of herbicides may well help in zero-tillage.
- When using zero tillage it is important to use rotations, monitor pests and diseases and beware of surface compaction.

At commercial level technology has brought in minimum tillage compatible planters such as zero till planters, strip till planters or minimum till planters which can plant in untilled soils or even soils with previous crop residues.

**Conventional Tillage**
This normally follows this procedure:
Ripping, Discing and Rolling or
Ploughing, Disicing and Rolling
Chisel Ploughing, Discing and Rolling

Deep/Primary tillage such as Ripping, Ploughing or Chisel Ploughing are normally recommended after 2 or 3 seasons of soil use. Discing and Rolling are called Secondary tillage procedures.

**Crop protection**

**CROP PROTECTION**
Crop protection is concerned with ensuring that pests, diseases and weeds are maintained at levels, which do not cause economic damage to crops. It begins with giving the crop every opportunity to grow well, which includes:
- maintaining diversity and rotations,
- good soil fertility management and timely planting, and
- conservation of soil and water.

When pests, diseases and weeds become a problem, crop protection relies on correctly identifying the nature and extent of the problem and knowing how best to prevent or control the problem. Thus, the starting point is knowing the various
weeds, pests and diseases which may affect your crops. This manual does not go into great detail on this aspect, because there are numerous weeds, pests and diseases. Make it a goal to learn about these problems by inquiring from extension personnel and by studying specific farming books. In addition, "scout" fields regularly in order to detect and predict the numbers of weeds, pests and diseases. Crop scouting is a form of insurance. The benefits of scouting are:
- control measures are only applied when needed, and
- fields are saved from unexpected losses through early detection and control.

Successful scouting of fields relies on the following:
- knowledge of the crop and the expected weeds, pests and diseases,
- frequent scouting, at least weekly visits to each field are required,
- representative areas of each field should be visited,
- plants must be thoroughly examined, including the roots, stems, leaves, flowers and fruit, and
- maintain written records of observations. In the case of cotton, there are specialised scouting forms and pest threshold levels available that help to determine when to apply chemical control measures.

Crop protection does not mean that every pest, disease and weed must be eradicated, for in fact this is quite impossible. In many cases, low levels of pests, weeds and diseases have little effect on crops, but the farmer must be able to anticipate, observe and be prepared to protect crops from pests, weeds and diseases. Generally, the time to apply control measures is when a rapid increase in pests, weeds and diseases begins. Once pests, weeds and diseases are abundant and proliferating, control is difficult, and irreversible damage to crops has usually taken place.

Crop protection chemicals may be used to prevent or cure problems. In either case, the chemical must be used according to the instructions given. Therefore, it is important that the farmer:
- knows what the problem is and how to control it
- selects the appropriate chemical which is the least toxic to humans and the environment (i.e., green label)
- reads, understands and follows the label instructions,
- applies the chemical at the correct time, in the correct manner and at the right dosage rates,
- ensures that the spraying equipment is functioning properly, and
- follows the appropriate safety precautions.

Matter of fact: Check list for choosing the right chemical:
- Is it safe for the crops following in the rotation?
- Is it effective?
- Is it appropriate for the problem?
- Is it safe for the user and environment?
- Is it economically viable?
- Can it be safely and correctly applied using available machinery?

Matter of fact: Tips on safe use of crop chemicals
- Do not contaminate the environment. Pesticides must not be spilt into water, onto the soil or in houses.
- Always read and understand the label on the pesticide container before use. Store pesticides in a cool, dry and ventilated place that may be securely locked and is out of reach of children.
Wear protective clothing when handling and using pesticides. The more toxic a pesticide the more the necessity for protective clothing. This should include a hat, visor, overalls, apron, gloves and boots.

Never eat, drink or smoke while using pesticides.

Dispose of empty pesticide containers in such a way that they will not cause a hazard to humans or animals. Never use empty pesticide containers for food or water storage.

Only use appropriately designed equipment to apply chemicals.

HARVESTING AND HARVESTING PREPARATIONS

Plan ahead and prepare for the harvest

Farmers should plan for harvesting, prepare equipment early and set/calibrate machinery, packaging/bagging materials and dryers should be in place and ready. In addition, at least two full days will be needed to check machinery for proper maintenance, adjustments and safety before harvest usually around April/May. We advise farmers to review owner's manuals of their harvesting implements before making adjustments.

We suggest farmers to book combines and transport on time

Health checks on combines should be done around April/May

Check moisture levels to allow for planning

Harvesting and drying can commence when the crop reaches a maximum moisture level of 20% and below. It makes an economic sense to harvest and dry a crop at this moisture level. The optimum acceptable storage moisture levels for maize grain is 12.5% and below.

Harvesting methods and tips

Hand harvesting

Bang Board Trailer

This is an option to farmers who cannot access combine harvesters. Cobs are loaded (by throwing) directly into a tractor drawn trailer which is fitted by a bang board. We recommend 6 rows to be harvested on each side of the trailer at a time. This is because workers become less accurate as the number of rows increase and forward speed is also reduced. The cobs in the 2 rows straddled by the tractor wheels are harvested first and heaped on the sides or on the rows and loaded later or as the tractor passes.

Drums/Sacks and trailer:

When large harvest gangs are available we can recommend the drums and trailer method. Cobs are harvested into a 25 litre container or a 25kg empty bag then emptied into a tractor/animal drawn trailer. Larger containers can also be used but 2 workers may reap into one container. For efficiency, 2 tractors and 3 trailers will be ideal if the gang is large. The crop (with husks) is then shelled using a tractor driven sheller.

Using empty bags/sacks

Some farmers prefer reaping directly into sacks. This system is particularly useful when shelling is done in the field. The cobs are reaped into the sacks by reapers and they are emptied into tractor towed sheller. The ratio of reapers to waiter is 2:1. Reaping can be done directly into a towable sheller. However this has proved to be inefficient in most cases as reapers may fail to match sheller rate.

Mechanical harvesting
Combine harvesters are mostly used in commercial setups especially when area under crop exceeds 50Ha and are a modern harvesting technology which comes in two types (Conventional and Rotary types). A combine harvester performs a bout of functions in a single go...(cutting the stalks, picking, de-husking, shelling, winnowing, blowing out chaff, cleaning the grain and loading bins/trailers for delivery).

**With a combine:**

- The farmer is independent of labour hires
- There is faster rate of harvesting than with hand harvesting, so the method suits large hectarages.
- The machine can chop up the stoves for ploughing down and/or planting.
- This method works well with bulk handling operations.

**However:**

- When there are problems with cob rots, there is no possibility/provision of sorting out the affected cobs.
- The combine cannot pick up cobs lying on the ground and as a result it will not work efficiently on lodged crops.
- Steep slopes, small fields and moisture content (high) of the crop affect the efficiency of the machine.
- The combine cannot work well in densely weeded fields.

**What needs to be checked on a combine harvester?**

Harvesting losses must not exceed 3% when using a combine harvester and therefore it is important for farmers to do a ‘health check’ from ‘front to back’ using a check list provided by experts/suppliers. Always target ZERO breakdowns during the harvesting period. A health check is critical and NOW is the right time to do it. Part of the checklist/inspection points:

Fan belts, bearings (for wheels and shafts), chains, (check all inspection points), intake auger (check all chains), winnowing fan (which blows the chaff), grain pans/sieves, augers to grain tanks, straw shredders among other points must be checked and if need be rectified, adjusted or even replaced.

**Factors that affect combine efficiency and reaping output. Lookout!**

- **Crop moisture levels:** Dry crop and cobs are easier to pick, de-husk and shell. A crop can be harvested below 20% moisture content. Moisture levels above 20% can compromise harvester efficiency.

- **Cob placement and standability:** A variety with good standability and average cob placement is easily and efficiently harvestable. A lodging crop is difficult to harvest with a combine and can cause harvesting and yield losses. That is the reason why we always recommend varieties with good standability and to always plant at recommended population densities.

- **Land terrain:** a well prepared and levelled (even) land is easy and less costly to harvest. Otherwise speed must be adjusted/rather reduced if terrain is not even.

- **Combine : trailer/truck/bin ratio:** we always recommend farmers to strike a good balance of combine harvesters and trucks in the field for efficiency so that the combine must not stop to wait for bins.

**Gleaning**

Field inspection during harvesting is always recommended. All knocked down crops and fallen cobs must be picked up by gleaning gangs after the combine has passed. A relatively sizable gang is sent into the field to pick up the left overs
following a combine harvester. The collected left overs can be shelled by a sheller or fed into a running combine/sheller.

Grain drying

Harvesting when moisture content is high may necessitate drying the crop/grain to the optimum moisture level for shelling/storage. To maximise on land/irrigation utilisation, a farmer may be recommended to harvest a maize crop before reaching storable moisture level (12.5%). This will require drying the crop/grain which can be done naturally or artificially. With natural drying the cobs are left on the plant to dry or reaped and heaped in strips on open dry land/slabs. The cobs can also be reaped and put in cribs and left to dry to the required moisture content. Alternatively, grain is dried in bags; but this tends to be a very slow process. Normally natural drying is common when the weather is sunny. You must always make sure you that the rate of heat extraction when drying must not deform the grain otherwise it will lead to down grading of produce.

In artificial drying, the underlying concept is ‘forcing heat through the grain’. The heated air then causes moisture to evaporate from the grain. The rate of drying depends upon the temperature of drying air, velocity of the air through the grain and the uniformity of its distribution in the drying silo/chamber. Maximum temperature of drying air will depend on such factors as the type of crop to be dried, the use of the crop and the system of drying being employed.

Postharvest handling of grain

Grain can be stored as ‘bulk’ or bagged. The storage facility must be suited to the method of delivery. Bulk stored grain is loaded into bulk trailers/bins using augers. Bagged grain usually requires conveyors or labour for loading.

Bulk storage

There are many methods that can be used for the bulk storage. Examples are: above ground silos, bulk containers and bags stored in the open or in buildings. There are a number of pros for the bulk storage method. These include:

- It is more economical than bag storage
- Less supervision is required
- Labour requirements and handling are reduced
- It is more hygienic than bag storage

However bulk storage has some cons in that:

- It is costly in terms of capital outlay requirements than bagging

Conditions for bulk storage

- The maize grain must be dry; with less than 13.5% moisture content.
- The storage facility must be structurally sound and designed for loading and offloading.
- The storage facility must be weather tight and dry, thermally insulated from the sun’s radiation and also rodent free.
- The facility must be convenient for inspection, fumigation and cleaning
- The facility must be provisioned to allow loading (of grain by augers) and offloading of grain (from the field)

Chemical treatment for long term storage

Maize in storage can be affected by many pests including: maize weevil (*Sitophilus* spp), Indian meal moth (*Sitrotoga cereale*), Flour beetle (*Tribolium castaneum*), Sawtoothed grain beetle (*Oryzaephilus surinamensis*), Lesser grain borer (*Rhyzopertha dominica*), Larger Grain Borer (*Prostephanus truncates*), Rusty grain beetle and other storage pests. These post-harvest pests can cause
significant yield losses (eat into your pocket) if left uncontrolled hence we recommend the use of stored grain chemical protectants. Several options are available on the market.

NB: Always read chemical labels carefully, use safe practices and adequate protective gear during application. Always observe recommended pre-consumption intervals on the grain protectant labels.

**Grain storage**

This is a process which involves three basic steps i.e.

- **Sanitation** (Clean storage places, spray and fill up cracks)
- **Chemical treatment** (Apply grain protectants to the grain at recommended moisture levels)
- **Inspection** (Inspect stored grain regularly and check roofs and pests)

Stored grain may deteriorate if:

- the temperature of the grain is too high
- the moisture of the grain is too high
- the grain is diseased
- insects multiply in the stored grain
- rodents are allowed access to the grain
- the untreated grain is stored for a long time

Guidelines for successful storage of grain:

- Only store dry grain and keep it dry. (Damp grain or damp air will lead to rotten grain.) The ideal moisture content of grain for good storage is less than 13%.
- Grain may be dried naturally in the field while on the plant, but losses from termites, deterioration, theft and weevils may accrue if crops are left too long in the field. Thus, it is better to harvest crops as soon as possible after maturity and dry the grain in the sun where there is good airflow over the grain. Alternatively, artificial drying may be used for large quantities of grain. However, this requires some mechanical method to blow ambient or heated air through the grain, and it is consequently an expensive and technical process.
- Never store grain that has already been attacked by insects, unless the insects have been destroyed. Damaged grain will allow the entrance of diseases and the insects may have laid eggs in the grain, which may re-infect the stored grain.
- Never let rodents make their home in the grain store. Prevention is better than cure - keep rats out (Cats are an excellent way of controlling rats).
- Proper grain storage depends greatly on the storehouse. Build a good storehouse that keeps out thieves, rodents and moisture.

6. Before filling a grain store:
- Clean out thoroughly and fill in any cracks with mud or mortar.
- Burn the debris that is swept out of the grain store.
- Spray surfaces with Malathion or Kontakill, or paint the surfaces with goat or cattle manure and ash (burnt sunflower stalks or aloe leaves may be used).
- Mix a grain protectant chemical (e.g., pirimiphos/permethrin) with the grain during filling.
- Eucalyptus leaves can be mixed with maize grain to reduce weevil infestation.
- Alternatively, mix ash with the grain (3 to 10 kg ash per 100 kg grain). Burn a mixture of dry maize cobs, sunflower stalks and cow dung in order to produce the ash. Powdered (crushed) Syringa seeds also help to keep away insects.
- Small quantities of beans may be stored in a container with some sand. At frequent intervals (at least every two weeks) shake the container to mix the sand and the beans.
- Always use the oldest grain first. Remember the maxim: first in, first out.

CROP PLANNING AND BUDGETING

Matter of fact: Success favours better planners

6 PHASES IN PLANNING

Step 1: Identifying and setting farm and household goals.

Step 2: Conducting a resource inventory (availability, quantities and quality).

Step 3: Organising resources into whole farm plan.

Step 4: Estimating costs and returns (enterprise budgeting).

Step 5: Organising enterprise budgets into whole farm budget.

Step 6: Implementation.
## High Management Farmer

**Crop:** Maize: Commercial

### Season
**2017/18**

### Area: Ha’s
**Sell:** May < Jun ’18

### Tonnes per ha
**Price per Tonne USD$**

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Rate per ha</th>
<th>Unit</th>
<th>Input Detail</th>
<th>Unit Cost USD$</th>
<th>% Total Cost</th>
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<tbody>
<tr>
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<td></td>
<td>450</td>
<td>kg</td>
<td>AN</td>
<td>0.600</td>
<td>23.68%</td>
<td>270.00</td>
</tr>
<tr>
<td></td>
<td>500</td>
<td>kg</td>
<td>Lime</td>
<td>0.091</td>
<td>3.99%</td>
<td>45.50</td>
</tr>
<tr>
<td>Herbicides</td>
<td>3.000</td>
<td>l</td>
<td>Atrazine</td>
<td>6.200</td>
<td>1.63%</td>
<td>18.60</td>
</tr>
<tr>
<td></td>
<td>1.500</td>
<td>l</td>
<td>Metalachlor</td>
<td>14.000</td>
<td>1.84%</td>
<td>21.00</td>
</tr>
<tr>
<td></td>
<td>50.000</td>
<td>g</td>
<td>Halosulfuron</td>
<td>0.800</td>
<td>3.51%</td>
<td>40.00</td>
</tr>
<tr>
<td></td>
<td>45.000</td>
<td>g</td>
<td>Nicosulfuron</td>
<td>0.556</td>
<td>2.19%</td>
<td>25.00</td>
</tr>
<tr>
<td>Insecticides</td>
<td>0.2</td>
<td>l</td>
<td>Lambda</td>
<td>10.000</td>
<td>0.18%</td>
<td>0.18%</td>
</tr>
<tr>
<td>Labour</td>
<td>15</td>
<td>day</td>
<td>Permanent</td>
<td>4.000</td>
<td>5.26%</td>
<td>5.26%</td>
</tr>
<tr>
<td>Tractor Hires</td>
<td>Wet Rate</td>
<td>l</td>
<td>Chisel Ploughing, Discing, Planting, Spraying</td>
<td>14.91%</td>
<td>14.91%</td>
<td></td>
</tr>
<tr>
<td>Harvesting (Combine)</td>
<td>30</td>
<td>l</td>
<td>Hire Charge</td>
<td>3.000</td>
<td>7.89%</td>
<td>7.89%</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>l</td>
<td>Diesel Usage</td>
<td>1.200</td>
<td>3.16%</td>
<td>3.16%</td>
</tr>
<tr>
<td>Transport/30ton</td>
<td>l</td>
<td></td>
<td>Delivered 50Km Radius</td>
<td>210.000</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Irrigation (Electricity +Z)</td>
<td>0</td>
<td>mm</td>
<td>Pumped from water body</td>
<td>-</td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
</tbody>
</table>

**Total Variable Costs**
100.00% 1

**Gross Income at 10.00 t/ha**
342.08% 3

**Gross Margin**
242.08% 2

**Return per $TVC**

**Gross Income @ 7 t/ha**
239% 2

**Gross Margin**
139% 1

**Return per $TVC**

Break even yield at $390/ ton price is 3t/Ha.
### Soyabean Gross Margin Budget

#### High management

<table>
<thead>
<tr>
<th>Gross Margin Guide/Ha</th>
<th>2017/18</th>
<th>Hecterage</th>
<th>Plant: Mid Nov-Mid-Dec’17</th>
<th>Price per Tonne</th>
<th>Tonnes per Ha</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

#### Inputs

<table>
<thead>
<tr>
<th>Rate per Ha</th>
<th>Unit</th>
<th>Input Detail</th>
<th>USD$ Costs</th>
<th>% Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seed</td>
<td>100.000 kg</td>
<td>SC Serenade, Safari, Status, Sequel</td>
<td>1.650</td>
<td>21.05%</td>
</tr>
<tr>
<td>Seed Dressing</td>
<td>1.000 kg</td>
<td>Innoculant</td>
<td>6.000</td>
<td>0.77%</td>
</tr>
<tr>
<td></td>
<td>0.250 kg</td>
<td>Thiram 80 WP</td>
<td>7.000</td>
<td>0.22%</td>
</tr>
<tr>
<td>Fertilizer and soil conditioners</td>
<td>250 kg</td>
<td>Soya Blend 5:12:24/ 6:27:20</td>
<td>0.700</td>
<td>22.04%</td>
</tr>
<tr>
<td></td>
<td>150 kg</td>
<td>Gypsum</td>
<td>0.140</td>
<td>0.00%</td>
</tr>
<tr>
<td></td>
<td>700 kg</td>
<td>Lime</td>
<td>0.100</td>
<td>0.00%</td>
</tr>
<tr>
<td>Herbicides</td>
<td>5.000 l</td>
<td>Glyphosate</td>
<td>6.500</td>
<td>4.15%</td>
</tr>
<tr>
<td></td>
<td>1.000 l</td>
<td>Metribuzine/Sencor</td>
<td>15.000</td>
<td>1.91%</td>
</tr>
<tr>
<td></td>
<td>1.500 l</td>
<td>Metalachlor</td>
<td>15.000</td>
<td>2.87%</td>
</tr>
<tr>
<td></td>
<td>0.035 kg</td>
<td>Classic</td>
<td>16.000</td>
<td>0.07%</td>
</tr>
<tr>
<td></td>
<td>2.000 l</td>
<td>Fusilade</td>
<td>28.000</td>
<td>7.14%</td>
</tr>
<tr>
<td>Insecticides</td>
<td>0.200 l</td>
<td>Lambda</td>
<td>9.000</td>
<td>0.46%</td>
</tr>
<tr>
<td>Fungicides</td>
<td>0.500 l</td>
<td>Triademnol</td>
<td>15.000</td>
<td>1.91%</td>
</tr>
<tr>
<td>Labour</td>
<td>20.000 day</td>
<td>Permanent/Hired</td>
<td>3.000</td>
<td>7.65%</td>
</tr>
<tr>
<td>Tractor Operations</td>
<td>50.000 l</td>
<td>Conventional 1 Tillage+1 planter+3 spraying+1 fertiliser app</td>
<td>1.200</td>
<td>7.65%</td>
</tr>
<tr>
<td>Combine</td>
<td>14.000 l</td>
<td>Hire Charge</td>
<td>7.500</td>
<td>13.40%</td>
</tr>
<tr>
<td></td>
<td>14.000 l</td>
<td>Diesel Usage</td>
<td>1.200</td>
<td>2.14%</td>
</tr>
<tr>
<td></td>
<td>2.000 l</td>
<td>Combine Trailer</td>
<td>4.547</td>
<td>8.16%</td>
</tr>
<tr>
<td>Transport</td>
<td>l</td>
<td>Delivered 30Km Radius</td>
<td></td>
<td>5.10%</td>
</tr>
<tr>
<td>Irrigation</td>
<td>- mm</td>
<td>Irrigation</td>
<td>0.780</td>
<td>0.00%</td>
</tr>
</tbody>
</table>

#### Total Variable Costs

- Total Variable Costs: 100.00%
- Gross Income at 3.5 t/ha: 245.60%
- Gross Margin before overheads: 35.80%
- Return per $TVC: 2.46

#### Gross Income at 2.50 t/ha

- Gross Income: 1,375.00
- Gross Margin before overheads: 591.20
- Return per $TVC: 1.75

#### Gross Income at 4.00 t/ha

- Gross Income: 2,200.00
- Gross Margin before overheads: 1,416.20
- Return per $TVC: 2.81

---

Break even yield at $550/ton price is 1.5t/Ha
**Sugar bean Gross Margin Budget**

**High management farmer**

<table>
<thead>
<tr>
<th>Land(s): Plant:</th>
<th>1,150</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area: Ha's</td>
<td>?</td>
</tr>
<tr>
<td>Sell:</td>
<td></td>
</tr>
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</table>

### Inputs

<table>
<thead>
<tr>
<th>Rate per Ha</th>
<th>Unit</th>
<th>Source</th>
<th>Input Detail</th>
<th>% Area</th>
<th>Unit Cost</th>
<th>% Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>kg</td>
<td>SC Sharp</td>
<td>Seed</td>
<td>100%</td>
<td>2.400</td>
<td>25.66%</td>
</tr>
<tr>
<td>100</td>
<td>kg</td>
<td>Compound &quot;DD&quot; 13:26:13 OM</td>
<td>Fertilizer and Lime</td>
<td>100%</td>
<td>0.840</td>
<td>8.98%</td>
</tr>
<tr>
<td>200</td>
<td>kg</td>
<td>AN PO</td>
<td>100%</td>
<td>0.680</td>
<td>14.54%</td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>kg</td>
<td>Lime GW</td>
<td>0%</td>
<td>0.100</td>
<td>0.00%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rate per Ha</th>
<th>Unit</th>
<th>Source</th>
<th>Input Detail</th>
<th>% Area</th>
<th>Unit Cost</th>
<th>% Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.00</td>
<td>l</td>
<td>Alachlor/Lasso (Pre) TSA</td>
<td>Herbicides</td>
<td>100%</td>
<td>5.450</td>
<td>23.32%</td>
</tr>
<tr>
<td>3.00</td>
<td>l</td>
<td>Basagram (LB) PI</td>
<td>0%</td>
<td>15.000</td>
<td>4.81%</td>
<td></td>
</tr>
<tr>
<td>0.60</td>
<td>l</td>
<td>Fusilade (PoE) TSA</td>
<td>15%</td>
<td>20.000</td>
<td>1.28%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rate per Ha</th>
<th>Unit</th>
<th>Source</th>
<th>Input Detail</th>
<th>% Area</th>
<th>Unit Cost</th>
<th>% Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10</td>
<td>l</td>
<td>Belt (Sytemic Pests) PO</td>
<td>Insecticides</td>
<td>200%</td>
<td>234.000</td>
<td>2.50%</td>
</tr>
<tr>
<td>1.00</td>
<td>l</td>
<td>Diazinon (Bean stem maggot) TE</td>
<td>300%</td>
<td>12.000</td>
<td>1.28%</td>
<td></td>
</tr>
<tr>
<td>0.15</td>
<td>l</td>
<td>Lambda (Cut Worm/Boll worm/LE) TSA</td>
<td>100%</td>
<td>4.000</td>
<td>0.06%</td>
<td></td>
</tr>
<tr>
<td>1.50</td>
<td>l</td>
<td>Thionex 35 EC (Boll Worm) INT</td>
<td>200%</td>
<td>9.000</td>
<td>1.44%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rate per Ha</th>
<th>Unit</th>
<th>Source</th>
<th>Input Detail</th>
<th>% Area</th>
<th>Unit Cost</th>
<th>% Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00</td>
<td>l</td>
<td>Copper Oxy PO</td>
<td>Fungicides</td>
<td>200%</td>
<td>8.000</td>
<td>0.86%</td>
</tr>
<tr>
<td>1.00</td>
<td>kg</td>
<td>Dithane M45 PO</td>
<td>200%</td>
<td>2.000</td>
<td>0.21%</td>
<td></td>
</tr>
<tr>
<td>0.50</td>
<td>l</td>
<td>Folicur (Rust) PO</td>
<td>200%</td>
<td>14.500</td>
<td>0.78%</td>
<td></td>
</tr>
</tbody>
</table>

| Labour | 20 | day | Permanent | 100% | 3.000 | 6.42% |

| Tractor Operations | 25.00 | ltr | Minimum Tillage | 100% | 4.547 | 12.15% |

| Transport | - | ltr | Delivered 30Km Radius | 100% | 6.905 | - |

| Irrigation | 200 | mm | 100% | 0.780 | 16.68% |

| ZINWA Charges | 1.5 | | 0.0% | 87.000 | 0.00% |

### Totals

| Total Variable Costs | 935.22 |
| Gross Income at 2.50 t/ha | 307.41% |
| Gross Margin before overheads | 1,939.78 |
| Return per $TVC | 2.46 |

| Total Variable Costs | 935.22 |
| Gross Income at 2.00 t/ha | 2,300.00 |
| Gross Margin before overheads | 1,364.78 |
| Return per $TVC & Inc Yield / Margin | 2.46 |

| Total Variable Costs | 935.22 |
| Gross Income at 3.00 t/ha | 3,450.00 |
| Gross Margin before overheads | 2,514.78 |
| Return per $TVC & Inc Yield / Margin | 3.69 |

---

**Must be planted before the end of Feb or Jul to avoid Frost!!!**

Break even yield at $1150/Ton price is 1.2 t/Ha
## Wheat Gross Margin Budget
### High management farmer

**GUIDE ONLY**

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Rate per Ha</th>
<th>Unit</th>
<th>Input Detail</th>
<th>Est Unit cost USD</th>
<th>% Area</th>
<th>% cost</th>
<th>USD/$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tractor Operations</td>
<td>70</td>
<td>ltr</td>
<td>Conventional tillage</td>
<td>3.660</td>
<td>100%</td>
<td>13.0%</td>
<td>25</td>
</tr>
<tr>
<td>Fertilizer and Lime</td>
<td>250</td>
<td>kg</td>
<td>Blend 13:26:13 (P)</td>
<td>0.831</td>
<td>100%</td>
<td>10.5%</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>400</td>
<td>kg</td>
<td>Blend 13:26:13 (P)</td>
<td>0.831</td>
<td>0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td></td>
<td>#</td>
<td>350</td>
<td>Urea (W)</td>
<td>0.670</td>
<td>100%</td>
<td>11.9%</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>#</td>
<td>400</td>
<td>Urea (W)</td>
<td>0.670</td>
<td>0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td></td>
<td>#</td>
<td>1000</td>
<td>Lime (LaF)</td>
<td>0.100</td>
<td>0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>22.4%</td>
<td>44</td>
<td></td>
</tr>
<tr>
<td>Seed</td>
<td>125</td>
<td>kg</td>
<td>Wheat (SC)smart/nduna</td>
<td>1.344</td>
<td>100%</td>
<td>8.5%</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>#</td>
<td>100</td>
<td>Barley (Delta) Hope</td>
<td>1.000</td>
<td>0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8.5%</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Irrigation(gross 600mr)</td>
<td>600</td>
<td>mm</td>
<td>incl Electricity and ZINWA</td>
<td>0.781</td>
<td>100%</td>
<td>23.8%</td>
<td>46</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Herbicides</td>
<td>0.25</td>
<td>ltr</td>
<td>Banvel (PrCh)</td>
<td>20.000</td>
<td>100%</td>
<td>0.3%</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>0.75</td>
<td>ltr</td>
<td>MCPA (Po)</td>
<td>7.000</td>
<td>100%</td>
<td>0.3%</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.5%</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Bird Shield</td>
<td>6.00</td>
<td>kg</td>
<td>10 - Anthraquinone 50%()</td>
<td>8.25</td>
<td>100%</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Insecticides</td>
<td>0.50</td>
<td>ltr</td>
<td>Pesticide</td>
<td>10.000</td>
<td>100%</td>
<td>0.0%</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>0.50</td>
<td>ltr</td>
<td>Pesticide</td>
<td>14.000</td>
<td>100%</td>
<td>0.0%</td>
<td>1</td>
</tr>
<tr>
<td>Fungicide sprays x 2</td>
<td>1.50</td>
<td>ltr</td>
<td>Fungicide</td>
<td>15.000</td>
<td>100%</td>
<td>1.1%</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.3%</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Combine</td>
<td>1</td>
<td>ltr</td>
<td>Contract(AT)</td>
<td>130.000</td>
<td>100%</td>
<td>6.6%</td>
<td>13</td>
</tr>
<tr>
<td>Combine Fuel</td>
<td>14</td>
<td>ltr</td>
<td></td>
<td>1.130</td>
<td>100%</td>
<td>0.8%</td>
<td>1</td>
</tr>
<tr>
<td>Harvest Trailer</td>
<td>4</td>
<td>ltr</td>
<td></td>
<td>3.660</td>
<td>100%</td>
<td>0.7%</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8.1%</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Labour</td>
<td>15</td>
<td>day</td>
<td>Permanent (inc welfare)</td>
<td>6.381</td>
<td>100%</td>
<td>4.9%</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>day</td>
<td>Seasonal</td>
<td>5.815</td>
<td>100%</td>
<td>3.0%</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>hrs</td>
<td>O/Time x 3/2</td>
<td>0.598</td>
<td>100%</td>
<td>0.2%</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>27</td>
<td>hrs</td>
<td>O/Time x 2/1</td>
<td>0.798</td>
<td>100%</td>
<td>1.1%</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9.1%</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Drying</td>
<td>2.00</td>
<td>Tonne</td>
<td>2% removal.10%crop</td>
<td>30.000</td>
<td>10.0%</td>
<td>2.1%</td>
<td>4</td>
</tr>
<tr>
<td>Transport</td>
<td>7</td>
<td>Tonne</td>
<td>Delivered 50Km($0.156/km)</td>
<td>0.156</td>
<td>100%</td>
<td>2.8%</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>5.5</td>
<td>Tonne</td>
<td>Delivered 120Km($0.1596km)</td>
<td>0.156</td>
<td>0%</td>
<td>0.2%</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tonne</td>
<td>Fert/Seed/Chem 50Km($0.1)</td>
<td>0.156</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.0%</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Financing</td>
<td>0.00%</td>
<td></td>
<td></td>
<td>0.00</td>
<td>100%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Insurance</td>
<td>0.50%</td>
<td>%</td>
<td></td>
<td>0.50%</td>
<td>100%</td>
<td>0.9%</td>
<td>1</td>
</tr>
<tr>
<td>Levy (Marketing)</td>
<td>1.00%</td>
<td>%</td>
<td></td>
<td>0.00%</td>
<td>100%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

### Total Variable Costs

<table>
<thead>
<tr>
<th>Gross Income 7.00t/ha-Wheat, 5.50t/ha-Barley</th>
<th>177.6%</th>
<th>3,500.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross Margin before overheads</td>
<td>77.6%</td>
<td>1,528.90</td>
</tr>
<tr>
<td>Return per $TVC</td>
<td>1.78</td>
<td></td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Gross Income 7.0t/ha-Wheat, 6.5t/ha-Barley</th>
<th>177.6%</th>
<th>3,500.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross Margin before overheads</td>
<td>77.6%</td>
<td>1,528.90</td>
</tr>
<tr>
<td>Return per $TVC</td>
<td>1.99</td>
<td></td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Gross Income 8.0t/ha-Wheat, 7.0t/ha-Barley</th>
<th>202.9%</th>
<th>4,000.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross Margin before overheads</td>
<td>100.9%</td>
<td>1,988.98</td>
</tr>
<tr>
<td>Return per $TVC</td>
<td>1.99</td>
<td></td>
</tr>
</tbody>
</table>
MAIZE PRODUCTION

Soils and climate
Maize grows best on deep, well-drained, fertile soils, and where total seasonal rainfall exceeds 500 mm. Maize is reasonably tolerant to soil acidity, but if the soil is very acid, liming will improve the soil and enhance maize yields. Maize is susceptible to both drought and water-logging. Thus, poorly drained soils should be avoided, unless practices like ridge tillage, drainage and early planting are employed. Drought during the four week period spanning flowering (silking and tasseling) can cause serious yield losses, and therefore some form of water conservation is important (e.g., pot-holing, mulching, tied-ridges), especially in the drier areas. Temperatures above 38 degrees celcius affect yield by affaceting pollen viability while temperatures below 10 retards maize growth.

Fertilisation
The fertiliser requirements of maize depends on the soil fertility and yield target. Infertile soils require more fertiliser, as does a higher yield target. The two most important nutrients for maize are nitrogen and phosphorous, but maize also requires potassium and, on some soils, Zinc in small quantities. The first consideration for fertilising maize is manure, for it is an excellent source of nutrients and has many other benefits for soils. Bought inorganic fertilisers should be considered as a supplement to manure. The following table gives a general recommendation for fertilising maize with inorganic fertilisers:

<table>
<thead>
<tr>
<th>Fertiliser</th>
<th>Yield potential of maize</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Less than 3 t/ha</td>
</tr>
<tr>
<td>Basal fertilizer (e.g. 7:14:7)</td>
<td>0 to 3 bags/ha</td>
</tr>
<tr>
<td>(0 to 150kg/ha)</td>
<td>(100 to 250kg/ha)</td>
</tr>
<tr>
<td>Top dressing fertilizer (high N) e.g. ammonium nitrate</td>
<td>1 to 3 bags/ha</td>
</tr>
<tr>
<td>(50 to 150kg/ha)</td>
<td>(100 to 250kg/ha)</td>
</tr>
</tbody>
</table>

Facts:
- The yield potential largely depends on the variety, expected rainfall and on the management applied to the crop.
- The addition of manure and ash will greatly improve the response of maize to the applied fertiliser. Under commercial set ups addition of lime to acidic soils improve response to fertilisers.
- Fertiliser rates may be reduced after a drought, where manure and ash is applied or when the maize is following a legume or well-fertilised crop, like potatoes.
- The basal fertiliser must be applied before or at the time of planting, preferably cupped into the planting hole, or applied in a band below and to the side of the seed with the mechanical planter.
- The top dressing should be applied when the maize at 3.5 to 6 Weeks After crop Emergence-WACE.
- Top dressing splits may be recommended in sandy to sandy loam soils. A maximum of 3 usually is ideal.
Basal fertilisers which contains zinc are recommended for application every two to three years on sandy soils.

If boronated fertilisers are not normally applied as part of the rotation, then a boronated fertiliser should be applied every three years.

The approximate application rates (to the nearest half-bag) of inorganic fertilisers to crops can be determined from the following tables:

**Basal fertilizers e.g. 7,14,7**

<table>
<thead>
<tr>
<th>Plant Spacing</th>
<th>Cup size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between</td>
<td>Between</td>
</tr>
<tr>
<td>5</td>
<td>8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rows (Cm)</th>
<th>Plants (Cm)</th>
<th>Fertilizer rate (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>50</td>
<td>125 200 275 375 525</td>
</tr>
<tr>
<td>90</td>
<td>60</td>
<td>100 175 250 350 475</td>
</tr>
<tr>
<td>90</td>
<td>50</td>
<td>125 250 300 425 575</td>
</tr>
<tr>
<td>90</td>
<td>30</td>
<td>200 350 525 700 950</td>
</tr>
<tr>
<td>75</td>
<td>60</td>
<td>125 200 300 425 575</td>
</tr>
<tr>
<td>50</td>
<td>50</td>
<td>250 375 550 750 1050</td>
</tr>
</tbody>
</table>

**Top Dressing Fertilizers (TOP) e.g. 34.5% N**

<table>
<thead>
<tr>
<th>Plant Spacing</th>
<th>Cup size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between</td>
<td>Between</td>
</tr>
<tr>
<td>5</td>
<td>8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rows (Cm)</th>
<th>Plants (Cm)</th>
<th>Fertilizer rate (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>50</td>
<td>100 150 250 325 450</td>
</tr>
<tr>
<td>90</td>
<td>60</td>
<td>100 150 225 300 400</td>
</tr>
<tr>
<td>90</td>
<td>50</td>
<td>100 175 250 350 500</td>
</tr>
<tr>
<td>90</td>
<td>30</td>
<td>200 300 450 600 800</td>
</tr>
<tr>
<td>75</td>
<td>60</td>
<td>100 175 250 350 500</td>
</tr>
</tbody>
</table>
NOTE:

! 1 ha = 2.5 acres
! 1 bag of fertiliser = 50 kg
! To convert kg/ha to bags per hectare, divide by 100 and multiply by 2.
! To convert kg/ha to kg per acre, divide by 2.5 (or multiply by 0.4).
! Specific amounts of fertilizer will vary according to the specific density of the fertilizer used.

Plant spacing

The width of rows and the spacing of plants in the row determines the plant population. The closer the spacing, the more plants there will be per unit area. The recommended number of maize plants per hectare varies from 36,000 to 60,000, depending on the environmental yield potential and hybrid. High plant populations are appropriate for early-planted crops under high rainfall or irrigated conditions where management is of a good standard. Lower plant populations should be used under dryland conditions, especially in drought prone areas, where a population of about 37,000 to 40,000 plants per hectare is recommended. Some varieties may be susceptible to lodging under high plant populations. Generally, the taller the variety, the lower should be the plant population. Short maize varieties may be grown at higher plant populations. Whatever the case, the minimum plant population for maize is 36,000 plants per ha.
The plant populations for the various Seed Co hybrids related to the expected yield is presented in the Table below:

### HYBRIDS

<table>
<thead>
<tr>
<th>HYBRIDS</th>
<th>SC719</th>
<th>SC727</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected Yield</td>
<td>SC403</td>
<td>SC513</td>
</tr>
<tr>
<td>T/ha</td>
<td>SC417</td>
<td>SC529</td>
</tr>
<tr>
<td>1</td>
<td>SC419</td>
<td>SC419</td>
</tr>
<tr>
<td>36000</td>
<td>32000</td>
<td>36000</td>
</tr>
<tr>
<td>36000</td>
<td>36000</td>
<td>32000</td>
</tr>
<tr>
<td>40000</td>
<td>40000</td>
<td>40000</td>
</tr>
<tr>
<td>44000</td>
<td>44000</td>
<td>40000</td>
</tr>
<tr>
<td>48000</td>
<td>44000</td>
<td>44000</td>
</tr>
<tr>
<td>52000</td>
<td>48000</td>
<td>44000</td>
</tr>
<tr>
<td>56000</td>
<td>55000</td>
<td>48000</td>
</tr>
<tr>
<td>60000</td>
<td>52000</td>
<td>49000</td>
</tr>
<tr>
<td>56000</td>
<td>50000</td>
<td>50000</td>
</tr>
<tr>
<td>60000</td>
<td>55000</td>
<td>60000</td>
</tr>
<tr>
<td>55000</td>
<td>60000</td>
<td>60000</td>
</tr>
<tr>
<td>55000</td>
<td>60000</td>
<td>60000</td>
</tr>
</tbody>
</table>

A seed rate of about 25 kg/ha is required, but this depends on the seed size. 10 kg is enough to plant 1 acre and 5 kg for half an acre. Small seed will go further, and give equal germination and yield performance as large seed. However, small seed should not be planted too deep (i.e., not deeper than 5 cm). For SC 727, a 50,000 kernel (1 hectare pack) is enough to plant 1 Ha, 20,000 kernel for 1 Acre.

The following table gives the number of plants per hectare at various spacings for hand planting:

<table>
<thead>
<tr>
<th>Spacing between rows (cm)</th>
<th>Spacing between plant station (cm)</th>
<th>Number of plants per station</th>
<th>Plant population (plants per ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>60</td>
<td>2</td>
<td>33 300</td>
</tr>
<tr>
<td>100</td>
<td>50</td>
<td>2</td>
<td>40 000</td>
</tr>
<tr>
<td>90</td>
<td>60</td>
<td>2</td>
<td>37 000</td>
</tr>
<tr>
<td>90</td>
<td>30</td>
<td>1</td>
<td>37 000</td>
</tr>
<tr>
<td>90</td>
<td>50</td>
<td>2</td>
<td>44 400</td>
</tr>
<tr>
<td>Target Harvest Population Per ha</td>
<td>Required Planting Population Per ha</td>
<td>Average kernel Spacing in-row (cm)</td>
<td>Average number of kernels per row</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>------------------------------------</td>
<td>-----------------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Row width (m)</td>
<td>Row width (m)</td>
</tr>
<tr>
<td>25 000</td>
<td>28 070</td>
<td>0.75 0.90</td>
<td>0.75 0.90</td>
</tr>
<tr>
<td>32 000</td>
<td>35 100</td>
<td>38 32</td>
<td>2.6 3.2</td>
</tr>
<tr>
<td>38 000</td>
<td>42 100</td>
<td>32 26</td>
<td>3.2 3.8</td>
</tr>
<tr>
<td>44 000</td>
<td>49 100</td>
<td>27 23</td>
<td>3.7 4.4</td>
</tr>
<tr>
<td>51 000</td>
<td>56 100</td>
<td>24 20</td>
<td>4.2 5.0</td>
</tr>
<tr>
<td>57 000</td>
<td>63 200</td>
<td>21 18</td>
<td>4.7 5.7</td>
</tr>
<tr>
<td>63 000</td>
<td>70 200</td>
<td>19 16</td>
<td>5.3 6.3</td>
</tr>
<tr>
<td>69 000</td>
<td>77 200</td>
<td>17 14</td>
<td>5.8 6.9</td>
</tr>
</tbody>
</table>

Note: The required planting population was calculated assuming 95% germination and 5% field loss.
New trends in population density management-commercial

Some farmers are pushing their population density higher than the recommended in search for ‘compensatory yield increases’. The farmers are targeting populations densities such as 65 000, 70 000, 80 000 up to 100 000 are being achieved. The trend or condition is that the farmers are coming in with a growth regulator such as CeCeCe (@ 2.1l/Ha) and Ethrel before day 35 after emergence. However this comes at a cost in terms extra seed cost, extra compensatory fertilization, spraying cost, and risk of response failure especially when spraying times coincides with extended wet periods.

There is need for further research especially the whether the yield gains are significant (or if they do exist in the first place), profitability of this concept, breeding for short statured but high yielding varieties to accommodate high densities. However we recommend optimum population densities of 50 000 to 60 000 plants per Ha on all Seed Co varieties in Zimbabwe.

Planting date

The later maize is planted, the lower the yield, as shown in the graph below. Highest yields are obtained with October plantings, but these can usually only be sustained with irrigation (ie irrigation to establish crop). However, planting in October may be feasible on vleis or when there is good early rain (over 50mm). November planting with the onset of the first rains is the safest under dryland conditions. In order to exploit these early rains, fields need to be ready before the rains (i.e. in October) and seed and fertiliser must be on hand, so that as soon as the first rains fall, fields may be planted. Planting in December will produce low yields, and is very risky, because the crop may suffer from drought stress at the end of the season, while pests (e.g. stalk borer) and diseases (maize streak virus and HT) are more prevalent on late planted crops. Under rainfed situations, after second week of November a farmer is encouraged to dry plant anyway at a depth of about 5 cm to ensure the seed is not reached by light showers.
On average, for every day that planting is delayed, the yield loss is one bag (50 kg) per ha. This is a significant loss and something to be remembered by those who wish to be productive farmers. Early planting with the right Seed Co maize hybrid, together with fertiliser and manure and the control of early weeds will make a large difference to the productivity of farmers’ fields.

**Varietal choice**

The choice of variety depends on the yield potential, season length, anticipated disease problems and use. The Seed Co Product Manual gives descriptions and recommendations of all the Seed Co hybrids on the market. It is best to study that manual and determine which hybrid will be best for each situation.

Considerations when choosing maize hybrid varieties  
✓ amount and distribution of rainfall  
✓ length of the growing season  
✓ altitude and air temperature  
✓ soil fertility and fertiliser application  
✓ planting date  
✓ plant density  
✓ use (commercial grain, green mealie and silage)  
✓ occurrence of pests and diseases  
✓ management

**Pointer!**

*Always plant new certified Seed Co seed each year for maximum yields.*

Early maturing hybrids take between 120 and 140 days from planting to maturity, whereas medium to late maturing varieties take between 141 and 155 days to mature. However, the time to maturity for any variety depends on air temperature: the cooler the temperatures the longer the plants will take to mature. Seed Co Limited has a very simple way of differentiating their hybrids using animal symbols as given in the accompanying table.

[Put brochure here]

The range of hybrids available from Seed Co is continuously changing as we develop new hybrids with improved performance and disease tolerance. Therefore, it is important to keep oneself informed by attending field days and reading adverts.
It is a good idea to grow more than one maize hybrid on a farm. Approximately half the fields should be planted to a familiar variety that is most suited to your environment, one quarter to an earlier maturing hybrid and one quarter to a later maturing hybrid. Start planting with the later maturing hybrid and end with the earlier maturing hybrid. Also consider trying out a small area of one or two new hybrids to compare their performance with hybrids you know.

Altitude has an effect on the number of days from planting to flowering and maturity because the rate of development of maize is affected by air temperature. The warmer the weather, the faster crop development is. Higher temperatures at lower altitudes therefore have the effect of accelerating the development rate. Conversely, the lower air temperatures at higher altitudes retard development and extend the time taken to reach flowering and maturity. The graph below gives a rough guide as to the time from planting to maturity for the four groups of Seed Co maize hybrids:

The approximate time from planting to maturity for Seed Co maize hybrids at different altitudes

![Graph showing the approximate time from planting to maturity for Seed Co maize hybrids at different altitudes.](image)

**Key:**

- 700 series e.g. SC 727 and SC 719
- 600 Series e.g. SC 649, SC 637, SC 627, SC 633, SC 643
- 500 series e.g. SC 513, SC 533, SC 529
- 400 series e.g. SC 403, SC 419

**Planting**

Maize yield declines as planting is delayed after the first week of November. Therefore plant as early as possible. For hand planting, this may be achieved if the farmer is well prepared. The following guidelines help plan an early planting:

- Obtain fertiliser and seed in September or earlier.
- Prepare planting holes early (i.e., in August or September) and cup-in the compound fertiliser so that all fields are ready for planting by the end of October.
It is unwise to plant in October, unless substantial rain has been received (i.e., more than 50 mm rain (within 3 days) and the soil is wet down to 45 cm on clays and 60 cm on sands).

In November, after each rainfall event, check the soil moisture status by digging in the field. Sow seed if the soil is wet down to 30 cm on clay soils or 50 cm on sandy soils. If more than 25 mm of rain has fallen, plant as much as you can in two days and then stop until further rain is received.

If no planting rains have fallen by the second week of November, then dry plant. Ensure the seed is placed into dry soil at a depth of 5-6cm.

In all planting operations ensure the seed is well covered with loose soil and pressed, so as to achieve good seed-soil contact. Avoid covering the seed with clods or rocks.

Soaking seeds in water for 12 hours (overnight) hastens germination, but such seed must be planted into wet soil the day after soaking. However with this practice farmers should note that they will be washing away the fungicides and pesticides which are normally used to treat certified seed. These prevents early disease and pest infestations.

**Mid-season management**

1. Weed control, especially in the first 10 weeks after crop emergence is essential. Hoeing is effective, and is easiest when weeds are small and on small portions. However, if the fields are bigger enough and your management is good, herbicides are recommended. There is a wide selection of pre-emergence herbicides for maize, but a common combination is Alachlor/Metalachlor and Atrazine applied pre-emergence. When applying herbicides, read and follow the label instructions and take the necessary safety precautions.

2. Rain-harvesting techniques should be employed as early as possible, e.g., mulching, pot-holing, tied-riding or wet ripping. This is particularly beneficial in the dry areas where rainfall is unreliable.

3. Top dress with Ammonium Nitrate/Urea when the maize is 4 to 6 weeks old. Maize on sandy soils may require a split top-dressing, with the first half applied at 4 weeks and the second at 7 weeks after emergence. Use appropriate sized fertiliser cups to place the fertiliser near each plant, or dribble-band the fertiliser along the row with a suitably calibrated pipe attached to a bag (chola). Fertiliser applicators are recommended to band top dressing fertilizer on the interrows. These can be calibrated and adjusted depending on the intended rates.

4. Check for stalk borer damage at 4 to 6 weeks after planting. The characteristic evidence of early infection of stalk borers is the appearance of numerous small holes in the new leaves in the funnel. If necessary apply insecticide granules or sprays into the funnels of the maize plants to control stalk borers. It is important to control the first generation of stalk borers, otherwise a second generation may develop which will be more numerous and difficult to control.

5. Start to check for Fall Army Worm damage at 2 to 3 weeks after planting and make spraying decisions early before damage reaches economic levels. Leaves show typical bullet-shot holes and leaves dry horse manure-like droppings called frass on the leaves particularly the central whorl. Leaves show a typical “window pane” damage. The damage includes holes on the stem causing significant stalk lodge, the cob and the tassel.

6. Control late weeds with the hoe or herbicides from flowering onwards, as this reduces weed pressure, weed seed reservoirs, and also makes the harvesting operation easier.

7. Harvest the crop as early as possible to reduce in-field losses. If whole cobs are harvested and placed in an outside grain crib for storage until shelling, protect this from rain. Shell the cobs as soon as possible to minimise infection by weevils. Store the grain when it is dry and protect it from insects and rodents. The best place for grain storage is a cool dry room that prohibits the entry of moisture and rodents. The application of a grain protectant chemical will prevent infection by weevils and other storage pests.

**Hard facts about weeds in maize**

- The annual yield loss in maize as a result of weed problems can reach 50% or more.
- The crop must have a good head start ahead of weeds.
- The crop must be weed free for the first 10 weeks of the crop cycle after crop emergence.
- This is the most critical time when the crop requires at least 50% of the nutrients and hence must be weed free.
- If you fail to control weeds in maize in the first 5 weeks of the crop cycle, then 50% of the yields will be lost.
- Never allow weeds to seed, it will enhance the weed seed bank and result in future weed control costs increases and difficulties.
There are more than 20 herbicides registered in Zimbabwe which can be sprayed on maize crop. The choice is very wide!

**Yield forecasting in maize**

**Steps:**
- Walk the land to ensure that the stand is even, standing (not lodging) and has no many gaps
- Reap the cobs from a measured 20 sq. metres. If the rows are at 90cm, then you should reap 22m row length, if the rows are 75cm, then measure 26.6m row length.
- Shell the cobs, weigh the grain and determine the moisture content using a moisture meter
- Do this for three or four separate samples at widely separate points and determine the average
- Use the formula below to calculate yield average estimate corrected to 1 ha and to 12.5% Moisture Content
  
  Mass Grain (Kg) x (100-moisture content)/ (100-12.5) x10 000/20

NB: The formula automatically correct the final yield to 12.5% moisture content
SORGHUM PRODUCTION

This falls under small grain cereals which are drought tolerant and should be included in rotations on small-scale farms. Not only may the grain be used for human food, but they are also useful for livestock feeding and silage. A break of two or three years between sorghum crops is recommended because sorghum is susceptible to nematodes. Rotate with broadleaf crops, like soyabean or groundnuts.

Soils and climate
These crops grow best in warm areas. They are grown on a wide range of soils. Sorghum is sensitive to nematodes, especially on sandy soils, and therefore sorghum must not be grown continuously on its own nor in a close rotation with maize.

Fertilisation
Sorghum does not do well on sandy soils. Generally, little fertiliser is required or applied to small grain crops. However, they will respond to manure applications, and where the rainfall is favourable, sorghum, in particular, will respond well to a low application of basal fertilizer (100 to 300 kg of 7.14.7 per ha) followed with a top dressing of 100 to 200 kg per ha of 28 - 34% N fertilizer. Sorghum also favours a soil pH of 5.5 to 6.8 on a Calcium Chloride Scale.

Varietal choice
The two preferred varieties in Zimbabwe are:
SC SILA
- Used for human consumption and livestock feed.
- Medium maturing variety with a good yield potential of up to 6 T/Ha.
- Short statured and does not lodge easily.
- Tolerant to most sorghum diseases.

SC SMILE
- Brown seeded OPV with good brewing qualities.
- Early maturing variety.
- Stiff straw that averts lodging.
- High yield potential of up to 6 T/Ha under good management.

Characteristics of Seed Co Sorghum varieties

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>MACIA</th>
<th>SC SILA</th>
<th>SC SMILE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant height cms</td>
<td>150</td>
<td>150</td>
<td>80-100</td>
</tr>
<tr>
<td>Days to maturity:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lowveld (below 800 m)</td>
<td>110</td>
<td>110</td>
<td>105</td>
</tr>
<tr>
<td>Middleveld (800 – 1,200 m)</td>
<td>120</td>
<td>120</td>
<td>113</td>
</tr>
<tr>
<td>Highveld (over 1,200m)</td>
<td>130</td>
<td>130</td>
<td>120</td>
</tr>
<tr>
<td>Leaf Blight Score</td>
<td>2.4</td>
<td>2.2</td>
<td>4.1</td>
</tr>
<tr>
<td>Sooty Stripe Score</td>
<td>4.6</td>
<td>4.5</td>
<td>1.4</td>
</tr>
<tr>
<td>Mass/1,000 seed (g)</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Grain Colour</td>
<td>White</td>
<td>White</td>
<td>Brown</td>
</tr>
</tbody>
</table>
Production practices

- It is not advisable to continuously plant a sorghum crop due to pest build-up.
- Spacing: 75 X 5 cm, 5 – 7 kg seed/ha for small seed and up to 10 kg for large seed. Final stand for SC Smile SC Sila and Macia should be 200 000 and 250 000 plants/ha, respectively.
- Planting Time: From end of November through to end of December in Zimbabwe.
- Keep fields weed free by making use of herbicides or hoe weeding
- Scout for aphids and bollworm during head emergence and grain filling periods.
- Harvest early to avoid bird damage and should engage bird scares when growing susceptible varieties.

Nutrients required per tonne of grain

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Total uptake (Kg)</th>
<th>Nutrients removed In grain (Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen (N)</td>
<td>30</td>
<td>18.0</td>
</tr>
<tr>
<td>Phosphate (P2 O5)</td>
<td>10</td>
<td>7.2</td>
</tr>
<tr>
<td>Potash (K2O)</td>
<td>30</td>
<td>5.4</td>
</tr>
</tbody>
</table>

Planting

- Small grain crops may be planted after maize in early December. They can be sown in 50 to 100 cm rows. A seeding rate of 5 to 15 kg is recommended depending on variety and use.
- Basal fertilizer is broadcast and incorporated by discing before planting can commence. The common practice of planting is broadcasting seed on a well ploughed land (with fine tilth) and covering lightly using a light harrow, roller, bush drag by cattle over the lands and covered to a depth of 2-3 cm.
- Mechanical planting using seed drill can also be done but this will require high seed rates and will require more labour for thinning.

Thinning

- Thinning should be done to establish an in-row spacing of 15-20 cm and this should be done before tilling begins and is normally done 4 weeks after emergence.
- At this stage it is also recommended to fill in for the seeds that did not germinate or seedlings that were affected by diseases.
Recommended seed spacings, seed rate and populations for sorghum

<table>
<thead>
<tr>
<th>Average Annual Rainfall</th>
<th>Below 500</th>
<th>500 - 650</th>
<th>650 - 800</th>
<th>Irrigated</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Recommended plant population</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>60000</td>
<td>90000</td>
<td>110000</td>
<td>250000</td>
</tr>
<tr>
<td><strong>Row Width</strong></td>
<td>90cm</td>
<td>155</td>
<td>85</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>75cm</td>
<td>140</td>
<td>100</td>
<td>75</td>
</tr>
<tr>
<td><strong>Within row seed spacing (mm)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Seed Rate</td>
<td>5kg/ha</td>
<td>8kg/ha</td>
<td>12kg/ha</td>
</tr>
</tbody>
</table>

**Pests**

- **Aphids**: These usually appear during head emergence and flowering. If necessary, spray with Dimethoate (Rogor) or Mercaptothion (Malathion).
- **Heliothis bollworm**: These caterpillars may attack the heads after flowering. Control with Thiodan before 1st February or with synthetic pyrethroids from February onwards.
- **Stalk borer**: This is the same pest as in maize. If necessary, use trichlorfon (Dipterex) or Endosulfan (Thiodan) granules applied in the funnels at 3 to 6 weeks after planting. Alternatively, spray into the funnels with Carbaryl. Extensive damage by stalk borers may result in the introduction of Fusarium stalk rot, stem lodging and considerable loss of grain yield.
- **Shoot fly**: Feeding larvae cause drying up of central leaf and dead heart symptoms on 1-4 week old seedlings. Timely planting, thionex and carbaryl are the chemical control remedies.
- **Spider mites**: Suck sap from the leaves to cause stunting especially rife during hot dry spells. Acaricides will be a good chemical control measure.
- **Birds**: These become a problem as the crop approaches maturity. Bird scaring is the only effective way of minimising bird damage, but community co-operation in planting dates may also help to spread the risk. Red/Brown sorghum is bird resistant.

**Diseases**

- **Leaf Blight**: This is common in southern Africa, and is favoured by moderate air temperatures and wet conditions or heavy dews. Dry weather retards the disease. Rotation with non-susceptible crops (non-grasses) aids in destruction of infected residue thereby reducing the level of primary infection.
- **Downey mildew**: Infested seedling leaves are chlorotic, stunted and premature death may result. Use of Seed Co resistant varieties is the smartest control method.
Smut: Ear head becomes swollen and turn grey. Use of Seed Co resistant varieties is the smartest control method

**Other management tips:**

- Sorghum is very sensitive to weed competition especially during the early stages of growth and establishment. Normally 2-3 hoe-weeding regimes are done even though the use of pre-emergence herbicides like atrazine can be recommended in soils with greater than 25% clay content. Control weeds throughout, but especially in the early stages of crop growth.
- Employ rain harvesting techniques (pot-holing or tied-ridging).
- Harvest early to minimise bird damage.
- If red sorghum destined for brewing is to be artificially dried, low air temperatures (35 to 38 degrees celcius) must be used in order to preserve grain quality and germination ability.

**Harvesting/drying/storage**

Harvesting is normally done when plants reach physiological maturity. Leaves will be turning yellowish and beginning to dry up naturally.

**Marketing**

Grain sorghum is marketed through the grain marketing board that presets the prices and also other private buyers such as milling companies, beer malting companies etc. Private companies like Delta can buy brewing sorghum from farmers mostly those under their growers’ contracts.
SOYABEAN PRODUCTION

Soils and climate
Soyabeans are legume plants suited to soils with a relatively high clay content, as they do not do very well on weak sands. The crop is also sensitive to soil acidity. Soyabeans require reliable rainfall, particularly from flowering to pod maturity. It is a good crop to grow in rotation with maize, cotton and wheat. The yields of these other crops are usually enhanced when following soyabeans, as shown in the Table below. Soyabeans are a nutritious addition to human and animal feed. It is also used in making cooking oil, margarine, soya chunks etc. It is the richest crop in terms of crude protein (ranges between 40-42 %) and contains 20 % oil.

The yields of wheat (t/ha) following either maize or soyabeans at different levels of nitrogen.

<table>
<thead>
<tr>
<th>Applied Nitrogen (kg/ha)</th>
<th>0</th>
<th>40</th>
<th>80</th>
<th>120</th>
<th>160</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Previous Crop</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maize</td>
<td>5.5</td>
<td>7.0</td>
<td>7.3</td>
<td>8.5</td>
<td>9.1</td>
<td>9.5</td>
</tr>
<tr>
<td>Soyabeans</td>
<td>6.4</td>
<td>7.2</td>
<td>8.0</td>
<td>9.4</td>
<td>10.0</td>
<td>9.5</td>
</tr>
</tbody>
</table>

Fertilisation
Since soyabeans are sensitive to soil acidity, check the soil pH (acidity or basicity) in winter. If necessary, apply lime at the recommended rate to bring the soil to a pH of 5.5 (CaCl2 scale).

Soyabeans grow well on residual fertiliser. However, a general recommendation is to apply a pre-plant application of 200 to 300 kg per ha of either a basal fertiliser (e.g. 7,14,7), Gypsum or Single Super Phosphate before planting, particularly where fertility is low. Soyabeans respond well to manure application. Soyabeans do not need much nitrogen in the basal fertiliser, and they do not require nitrogen fertiliser top dressing, since they are able to obtain their nitrogen requirements from the soil air.

For general application the following table gives a good guide:

Table 4: Average nutrient requirements of soyabeans kg/ha

<table>
<thead>
<tr>
<th>Nutrient status of soil</th>
<th>Nutrient status of soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nutrient</td>
<td>Good</td>
</tr>
<tr>
<td>N</td>
<td>Nil</td>
</tr>
<tr>
<td>P2 05</td>
<td>Nil</td>
</tr>
<tr>
<td>K2 0</td>
<td>Nil</td>
</tr>
</tbody>
</table>

On soils of poor to medium soil fertility, a small amount of fertiliser is recommended to sustain the crop for the first six weeks before effective nodulation occurs. The recommended fertiliser application is 150-200 kg of Compound L (Cottonfert) or Soya Blend applied as basal fertiliser.

It is therefore essential to apply Rhizobium inoculant to the seed at planting. This inoculant is obtainable from Seed Co. It is a living culture and must be handled properly for it to work effectively. In particular, do not leave the inoculant in a sunny, hot place, but rather store it in a cool, dark place. When ready to plant, the inoculum is mixed with a little water and sugar, and applied to the seed.
immediately prior to planting. Directions on the inoculum packet must be followed. One packet of inoculant is required for each 100 kg of seed. However, a higher rate is preferable on sandy soils or in first year soyabean fields.

**Variatel choice**

There are two basic types of soyabean cultivars: determinate and indeterminate. This refers to the way the plant grows. Determinate cultivars grow vegetatively for about six weeks and then begin flowering, having put on 10 to 12 leaves. Once flowering begins, no further new leaves are produced on the main stem. Indeterminate cultivars, on the other hand, grow vegetatively for about six weeks, then begin flowering when the main stem has about 10 leaves, but at the same time as flowering, the stem continues to grow for another three weeks or so, producing another five to seven leaves. Thus, the vegetative and reproductive growth periods overlap in indeterminate cultivars but not in determinate cultivars. Indeterminate cultivars also tend to grow taller than determinate cultivars. For these reasons, determinate cultivars are better suited to warm fast growing environments where irrigation is available, like the lowveld, whilst on the middleveld and highveld, both types are suitable. Under drought conditions, indeterminates may have some advantage over determinates. highveld, both types are suitable. Under drought conditions, indeterminates may have some advantage over determinates. Apart from the growth habit of the cultivars, farmers must choose cultivars that have a high yield potential, do not lodge, have a high clearance of pods from the ground, good resistance to disease and take a long time from maturity to pod shattering.

**Choosing the right soyabean variety**

When choosing a variety to grow in your particular farming area the following points are very important:
- The variety must fit in a growing season of 4 to 4 ½ months.
- The variety should give the highest yield for that particular area and season.
- The must be resistant to lodging especially where combine harvesters are used
- The variety should have a longer period between physiological maturity (time when no more dry matter is added to seed) and pod shattering.
- High pod clearance to reduce losses when harvesting with a combine harvester.
- Rapid stem dehydration.
- Resistance to diseases, especially Red Leaf Blotch (*Pyrenochaeta glycines*) Frogeye (*Cercospora sojina*), Soyabean Rust (*Phakospora pachyrhizi*).

Some of the farmers’ choice varieties available at Seed Co include:

<table>
<thead>
<tr>
<th>Indeterminate</th>
<th>Determinate</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC Serenade</td>
<td>SC Status</td>
</tr>
<tr>
<td>SC Safari</td>
<td>SC Sequel</td>
</tr>
<tr>
<td>SC Squire</td>
<td>SC Sentenel (New)</td>
</tr>
<tr>
<td>SC Saga</td>
<td>SC Santa</td>
</tr>
</tbody>
</table>

New varieties are continuously being produced, and therefore it is important to keep up to date with these, as the new ones always have an advantage over the old varieties in yield and agronomic traits.
### Characteristics of Seed Co soybean varieties

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Squire</th>
<th>Saga</th>
<th>Serenade</th>
<th>Safari</th>
<th>Santa</th>
<th>Siesta</th>
<th>Sequel</th>
<th>SC Spike</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth habit</td>
<td>Indeterminate</td>
<td>Indeterminate</td>
<td>Indeterminate</td>
<td>Indeterminate</td>
<td>Determinate</td>
<td>Determinate</td>
<td>Determinate</td>
<td>Determinate</td>
<td>Determinate</td>
</tr>
<tr>
<td>Recommended areas of production</td>
<td>Highveld &amp; Middleveld in Zimbabwe</td>
<td>Highveld &amp; Middleveld in Zimbabwe</td>
<td>Highveld &amp; Middleveld in Zimbabwe</td>
<td>Highveld &amp; Middleveld in Zimbabwe</td>
<td>All areas of Zimbabwe and Zambia</td>
<td>All areas of Zimbabwe</td>
<td>All areas of Zimbabwe</td>
<td>All areas of Zambia</td>
<td>All areas of Zimbabwe</td>
</tr>
<tr>
<td>Plant heights in centimetres</td>
<td>105.0</td>
<td>95.0</td>
<td>102</td>
<td>100</td>
<td>92</td>
<td>77</td>
<td>83</td>
<td>105</td>
<td>88</td>
</tr>
<tr>
<td>Pod clearance in centimetres</td>
<td>18</td>
<td>16</td>
<td>17</td>
<td>16</td>
<td>17</td>
<td>14</td>
<td>16</td>
<td>20</td>
<td>16</td>
</tr>
<tr>
<td>Lowveld</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>115</td>
<td>115</td>
<td>120</td>
<td>126</td>
<td>119</td>
</tr>
<tr>
<td>Middleveld</td>
<td>122</td>
<td>121</td>
<td>122</td>
<td>120</td>
<td>125 (118 in Zambia)</td>
<td>125</td>
<td>125</td>
<td>130</td>
<td>124</td>
</tr>
<tr>
<td>Highveld</td>
<td>128</td>
<td>127</td>
<td>128</td>
<td>125</td>
<td>130</td>
<td>129</td>
<td>128</td>
<td>140</td>
<td>127</td>
</tr>
<tr>
<td>Number of days to pod shattering</td>
<td>25</td>
<td>26</td>
<td>26</td>
<td>28</td>
<td>26</td>
<td>25</td>
<td>25</td>
<td>27</td>
<td>26</td>
</tr>
<tr>
<td>Seed Hilum colour</td>
<td>Yellow</td>
<td>Brown</td>
<td>black</td>
<td>Yellow</td>
<td>Brown</td>
<td>Yellow</td>
<td>Black</td>
<td>Brown</td>
<td>Brown</td>
</tr>
<tr>
<td>Mass of 1000 seeds (g)</td>
<td>230</td>
<td>215</td>
<td>230</td>
<td>210</td>
<td>216</td>
<td>255</td>
<td>210</td>
<td>190</td>
<td>136</td>
</tr>
<tr>
<td>Bacterial blight</td>
<td>2.5</td>
<td>2.0</td>
<td>2.6</td>
<td>2.0</td>
<td>1.9</td>
<td>1.8</td>
<td>2.5</td>
<td>1.2</td>
<td>2.1</td>
</tr>
<tr>
<td>Wildfire</td>
<td>2.1</td>
<td>2.0</td>
<td>1.0</td>
<td>1.0</td>
<td>2.0</td>
<td>1.0</td>
<td>1.6</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Downy mildew</td>
<td>1.0</td>
<td>2.0</td>
<td>1.2</td>
<td>2.0</td>
<td>1.3</td>
<td>1.4</td>
<td>2.0</td>
<td>1.3</td>
<td>1.8</td>
</tr>
<tr>
<td>Red leaf blotch</td>
<td>2.1</td>
<td>2.5</td>
<td>2.1</td>
<td>1.6</td>
<td>1.9</td>
<td>3.5</td>
<td>2.5</td>
<td>1.8</td>
<td>2.5</td>
</tr>
<tr>
<td>Frogeye leaf spot</td>
<td>1.2</td>
<td>1.3</td>
<td>1.2</td>
<td>1.2</td>
<td>1.5</td>
<td>1.5</td>
<td>1.3</td>
<td>1.4</td>
<td>1.5</td>
</tr>
<tr>
<td>Soyabeans rust (see Note 1 below)</td>
<td>1</td>
<td>1.5</td>
<td>1.2</td>
<td>1.6</td>
<td>3.0</td>
<td>4.0</td>
<td>3.0</td>
<td>4.3</td>
<td>3.0</td>
</tr>
</tbody>
</table>

Notes: 1st Digit 1= Bottom third of leaf canopy on the plants  2nd Digit 1= No lesions  2= Middle third of leaf canopy on the plants
**Planting and crop management**

The seed rate is about 90-100 kg per ha. The desirable plant population is around 350 000 plants per ha, but soyabean are capable of adapting to a wide range of plant populations. A minimum plant population is 200 000 plants per ha, while a maximum is 550 000 plants per ha. The higher the plant population, the greater is the danger of lodging, but the higher is the pod clearance. Shorter stature varieties like Status and sequel should be planted at a higher population than taller varieties.

The row spacing may be from 25 to 90 cm. The closer the row spacing, the higher the yield, but the yield advantage is not great (about 5 to 10 %). The wider the row, the closer are the seeds placed in the row, and this sometimes helps, especially for emergence on soils that have a tendency to cap (seal on the surface). Do not plant seed deeper than 5 cm. Be careful not to plant soyabean in such a way that when covered with soil they are in a furrow; rather the soil should form a slight mound over the row, as this makes it easier for the seedling to emerge. It is essential not to plant too deep. Seed should be planted 25-50 mm deep, depending on soil texture. If soil crusting occurs before emergence, wetting the soil with irrigation or breaking the crust with a 'millipede implement' will improve emergence.

The time to plant soyabean is after planting maize, but this should preferably be before mid-December.

A fungicide seed dressing of, for example, Thiram 80 WP (85 g/50 kg seed) or Flusilazole (Captan 50 WP at 125 g/50 kg seed) will help ensure good emergence.

Soyabean particularly sensitive to weed competition during the first six weeks of the season. Control weeds adequately during this period.

---

**SOYABEAN PLANTING GUIDE**

<table>
<thead>
<tr>
<th>Target</th>
<th>Required</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Harvest Population</td>
<td></td>
<td>Required average number of seeds</td>
<td></td>
<td>Seeding rate (kg/ha)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Per ha</td>
<td>Per ha</td>
<td>per metre of row</td>
<td>Row width (m)</td>
<td>Thousand seed weight (g)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>200000</td>
<td>248000</td>
<td>0.4</td>
<td>5</td>
<td>0.60</td>
<td>0.75</td>
<td>0.90</td>
<td>250</td>
<td>220</td>
</tr>
<tr>
<td>240000</td>
<td>297000</td>
<td>11</td>
<td>15</td>
<td>19</td>
<td>22</td>
<td>62</td>
<td>54</td>
<td>47</td>
</tr>
<tr>
<td>280000</td>
<td>347000</td>
<td>13</td>
<td>18</td>
<td>22</td>
<td>27</td>
<td>74</td>
<td>65</td>
<td>57</td>
</tr>
<tr>
<td>320000</td>
<td>396000</td>
<td>16</td>
<td>21</td>
<td>26</td>
<td>31</td>
<td>87</td>
<td>76</td>
<td>66</td>
</tr>
<tr>
<td>360000</td>
<td>446000</td>
<td>18</td>
<td>24</td>
<td>30</td>
<td>36</td>
<td>100</td>
<td>87</td>
<td>75</td>
</tr>
<tr>
<td>400000</td>
<td>495000</td>
<td>20</td>
<td>27</td>
<td>33</td>
<td>40</td>
<td>111</td>
<td>98</td>
<td>85</td>
</tr>
<tr>
<td>440000</td>
<td>545000</td>
<td>22</td>
<td>30</td>
<td>37</td>
<td>45</td>
<td>124</td>
<td>109</td>
<td>94</td>
</tr>
</tbody>
</table>
Mid-season crop management

Soyabean are very susceptible to drought during the flowering and pod-filling stage. The pod filling stage occurs in the last third of the crop's life, and the beginning of this stage is identified when the pods on the upper nodes of the main stem are 2 cm long and the small seeds are visible in the pods. If supplementary irrigation is available, this is the time to apply water, as it can produce large yield increases.

Supplementary irrigation (if available) should target these critical stages (i.e. if they coincide with dry spells):

For a crop taking about 125 days from planting to physiological maturity these critical periods will be as follows:-

- Germination - day 1 to day 6
- Flowering - day 55 to day 75
- Pod fill - day 95 to day 125

Pests and Diseases

Semi-looper caterpillars are often a problem during the flowering and seed-fill period. They eat the leaves and sometimes the pods. Semi-loopers are controlled in most seasons by a naturally occurring virus disease, which kills the caterpillars. Caterpillars that have died from the disease are black and hang from the leaves. These may be collected, crushed, mixed with water and sprayed around the field to help control other caterpillars. If the virus is not killing the semi-loopers then an insecticide spray may be required.

Two diseases have become prevalent in the region. The one is Frog Eye Leaf Spot (Cercospora sojina) and the other is Rust (Phakopsora pachyrhizi). Most cultivars available today are resistant to Frog Eye Leaf Spot, whilst latest varieties have shown some tolerance to Rust. The Rust disease may be recognised as numerous small grey to russet coloured tufts on the underside of leaves. They may appear similar to red spider mites. In advanced stages the leaves become
distinctly yellowy-brown, and a light brown cloud of spores, like dust, may be seen in and above the canopy when the plants are shaken. Since none of the present cultivars are tolerant none of the present cultivars are tolerant of the disease, it is usually necessary to control Rust with a fungicide spray. A number of chemicals are available, such as Carbendazim / Flusilazole (Punch® Xtra at 350 to 500 mL/ha) and Triadimenol (Shavit® at 500 mL/ha). Two, and even three, fungicide sprayings will be required at 3 week intervals beginning at first flower. When spraying, it is important to achieve good cover of all leaves, but especially the upper leaves of the canopy. The detrimental effect of Rust is severe: an unsprayed crop may yield less than one third of a sprayed crop.

A third disease of importance is Red Leaf Blotch (Pyrenochaeta glycines). Severe infections can reduce seed yields by 30% - 50%. Use of resistant varieties is the smartest control measure against this important diseases. Seed Co varieties have shown some resistance to this disease.

**Harvesting**

Soyabean should be harvested as soon as the plants have dried. If harvesting is delayed, the pods may shatter with a consequential loss of yield.

a) Hand harvesting. This method is suitable for small areas, or where a large labour force is readily available. The advantages of hand harvesting are that losses can be reduced to a minimum, soyabean of a high quality are produced, and the beans normally have a high viability. Therefore, hand harvesting is suitable for seed production. The usual system of hand harvesting is to allow labourers to cut or pull as much plant material as they are able to thresh in a day. For hand cutting, labourers require sickles or sharp hoes. A labourer should be able to cut and thresh at least 50 to 90 kg of clean beans per day.

b) Mowing or cutting by hand and shelling. A variation is to use a mower to cut the plant material, and a mechanical winnower for the final cleaning. This method should enable an output of ± 150 kg (3 bags)/labour/day. This method enables harvesting to commence before the pods split, but allows sufficient moisture to be lost, thereby preventing mould developing in the established cocks or stacks.

c) Swather plus combine. This method involves the use of a swather to cut and wind-row the crop before it is combined. A pick-up attachment (picker) is required to be fitted to the combine table.

d) Combine harvesting. Large areas are usually reaped by combine harvester and losses are inevitable. The degree of loss depends on the efficiency of the machine and operator, the evenness of the land, the height of the pods off the ground, lodging, the moisture content of the beans, and weed control. Machines must cut very close to the ground, and losses must be minimised by cutting at the correct moisture content and paying attention to machine adjustments. The golden rule for combining is to “take it low and take it slow”. Soyabean seed is delicate and can be easily damaged by the threshing mechanism which must be carefully adjusted and run slowly.
GROUNDNUT PRODUCTION

Groundnuts may be divided into three types, according to the time taken to maturity early, medium and late maturing. Early maturing groundnuts have a bunch growth habit, while medium and late maturing groundnuts have a spreading growth habit. This section deals only with early maturing groundnuts, commonly grown under dryland conditions.

Soils and climate

Best results are obtained from deep, well-drained soils in good condition. Suitable soils include sands and sandy loams. Groundnuts will not grow well on acid soils and thus liming may be necessary for good production (the ideal pH is 5.3 to 6.8). Groundnuts must not be grown on the same land more than once in every four years. Groundnuts are a good crop to grow before maize.

Early maturing groundnuts (e.g. SC Mwenje and SC Nyanda) take about 115 days or less to maturity on the middleveld. Late maturing groundnuts take about 160 days to maturity on the middleveld and hence not very suitable in a rainfed system.

Groundnuts are sensitive to cool overcast conditions both in the early part of the season and during pod filling. The ideal season is one which has much sunshine, coupled with sufficient rainfall, especially during pegging and pod-filling.

Varietal choice

Two sought after short season varieties are:

Nyanda

- A very short duration, taller-statured variety with a more open growth habit.
- Better seed appearance and uniformity.
- Two-seeded pods.
- Good kernel yields of 1t/ha.
- Drought stress tolerance.
- Resistant to aphids, Hilda and grain moth.

Mwenje

- A very short duration, taller-statured variety with a more open growth habit.
- Better seed appearance and uniformity.
- Two-seeded pods and good taste.
- Good kernel yields of 1.3t/ha.
- Drought stress tolerance.
- Resistant to aphids, Hilda and grain moth.
- Good rosette virus tolerance.
Characteristics of Seed Co Groundnut Varieties

<table>
<thead>
<tr>
<th>Varieties</th>
<th>SC Nyanda</th>
<th>SC Mwenje</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
<td>Short season &amp; Valencia type</td>
<td>Short season &amp; Valencia type</td>
</tr>
<tr>
<td><strong>Seed Colour</strong></td>
<td>Tan</td>
<td>Tan</td>
</tr>
<tr>
<td><strong>Use</strong></td>
<td>Edible Nuts &amp; Peanut Butter</td>
<td>Edible Nuts &amp; Peanut Butter</td>
</tr>
<tr>
<td><strong>Days to maturity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lowveld (below 900masl)</td>
<td>85-95</td>
<td>85-95</td>
</tr>
<tr>
<td>Middleveld (900-1250masl)</td>
<td>95-105</td>
<td>95-105</td>
</tr>
<tr>
<td>Highveld (above 1250masl)</td>
<td>105-105</td>
<td>105-115</td>
</tr>
<tr>
<td><strong>Defoliation at lifting (%)</strong></td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td><strong>Mass of 100 seeds (g)</strong></td>
<td>290</td>
<td>290</td>
</tr>
<tr>
<td><strong>Sound Mature Seeds (%)</strong></td>
<td>70</td>
<td>70</td>
</tr>
</tbody>
</table>

**Fertilisation**

- Basal fertiliser - Groundnuts should be grown in rotation with cereals (e.g., maize and sorghum), which have been well fertilised, because groundnuts respond well when fertiliser is applied to the previous crop rather than to the groundnuts themselves. Thus, in most cases, no basal compound fertiliser is applied. Nevertheless, where the soil is known to be infertile or deficient in some nutrients, manure or a low rate (150 to 300 kg/ha) of a basal fertiliser (e.g. 7,14,7 or 5,18,10) or Single Super Phosphate may be applied. Groundnuts respond well to manure, because the manure not only supplies nutrients, but also helps to ameliorate soil acidity.

- Top dressing. Groundnuts have a high requirement for calcium, especially during the pegging stage. Low availability of calcium at this stage will result in a large proportion of empty shells. Calcium may be supplied with Gypsum (calcium sulphate) at a rate of 250 kg per ha broadcast over the plants at flowering (7 to 8 weeks after planting).

**Crop establishment**

- Groundnuts should be planted as early as possible, at least before the end of November, but care must be taken not to plant too early otherwise they will be ready for lifting while the rains are still around, which will cause problems.

- Suitable short-season varieties include Nyanda and Mwenje. Nyanda has proven to be the best short season cultivar in trials throughout the drier regions.

- Plant groundnuts at a spacing of 35 to 45 cm between rows and 5 to 10 cm between seeds in the row. Seed requirements are about 100 kg per ha. Depth of planting is 5 cm.
Mid-season management

- Weed control is most important, especially in the early stages of crop growth. Weeding with hoes is possible up to the flowering stage. Thereafter, weeds must be pulled out by hand to avoid disturbance of the pegs.

- Diseases. Groundnuts are susceptible to a number of leaf diseases (e.g. Cercospora and Phoma), but control in short season groundnuts is not always necessary. Nevertheless, a single spray of a fungicide, for example, Mancozeb (Dithane M45) or Chlorothalonil (Bravo) at flowering or early pegging may be beneficial, especially in wet years where diseases may be problematic. With late maturing groundnuts, disease control is important.

- Pests. Aphids may be a problem and may be controlled with a pesticide, for example, Dimethoate (Rogor). Leaf eating pests and Heliothis bollworm may be controlled with chemicals like Carbaryl.

Harvesting

This is a critical aspect of groundnut production, because of the potential losses and disease infection that may occur at this time. Here are some points to consider:

1. Begin lifting groundnuts when 40 to 50% of the pods are mature. Pod maturity may be determined by counting out 100 pods from a number of plants and shelling these to separate the mature and immature kernels (seeds). Mature seeds have a seed skin (testa) that does not easily rub off, and which has a thin papery texture and has developed the colour of the variety. An immature seed has a thick, fleshy skin with a pale colour and which rubs off easily. Lifting should be complete by the time 70 to 80% of the seeds are mature or before plants are 90% defoliated.

2. The harvesting process includes loosening, lifting, wilting, cocking (curing), picking and finally shelling. It is important that once the plants are lifted they be allowed to wilt for a few days with the pods exposed to the air before cocking. When cocking the groundnuts, keep the plants off the ground, ensure the cock is constructed to allow free flow of air through the cock, to facilitate rapid drying, and construct the cock so that water cannot penetrate during rainy spells. Curing and drying may take from 2 to 4 weeks. Begin picking when the kernels rattle in the pods. It is possible to pick one to two bags per person per day.

3. Groundnuts must be dry before placing in a storehouse. The storehouse must be dry, cool and well ventilated. It is best to store groundnuts in their shells. Discard diseased, sprouted or insect-damaged pods and only store healthy, dry pods. Shelling of groundnut pods may begin anytime after the pods are dry. From 10 kg of unshelled nuts, there will be about 5 to 7 kg of shelled nuts.

4. One large bag of shelled groundnuts weighs about 80 kg. One large bag of unshelled groundnuts weighs about 35 kg.

5. Groundnuts may be sold to any dealer, but there are now small hand mills that make fine peanut butter, suitable for local markets, and which add value to the product.
**Production Guide in summary steps**

<table>
<thead>
<tr>
<th>Land preparation and planting</th>
<th>Flowering and vegetative stages</th>
<th>Harvesting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepare lands early.</td>
<td>Apply 100 - 300kg/ha Gypsum 7 - 8 weeks after germination.</td>
<td>Lift crop when 50 - 80% of pods contain mature kernels (ie. When the kernel skin is thin and difficult to rub off).</td>
</tr>
<tr>
<td>Apply lime, if required.</td>
<td>On sandy soils, apply two applications, one at 7 weeks and the other at 10 weeks.</td>
<td>After wilting, dry on “A”-frames or in cocks for 3 - 4 weeks, with pods inside to protect them from sunlight.</td>
</tr>
<tr>
<td>Seed dress with Thiram.</td>
<td>Avoid hoeing fields after onset of flowering - rather pull weeds out.</td>
<td>Pick pods when dry, discard diseased, sprouted or insect-damaged pods.</td>
</tr>
<tr>
<td>Sow seed as soon as effective rains fall.</td>
<td>Scout for pests and diseases and control as necessary.</td>
<td>Store in cool, dry place.</td>
</tr>
<tr>
<td>Rows 45cm apart.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seed 7.5cm apart in row.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seeding rate 100kg/ha.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Vegetative Growth Stages:**

- Ensure good weed control.
- Scout for aphids and other pests, apply control measures as necessary.

**Pegging and podding:**

- Ensure good weed control, but only hand-pull weeds. Do not use a hoe.
- Scout for pests and diseases and control as necessary.
SUGAR BEAN PRODUCTION

Soils and climate.
Beans may be grown on a wide range of soils, but they generally prefer soils with some clay content (> 15%), and they are sensitive to soil acidity. Beans are best grown during the cooler months of summer (January to April) on the highveld or in winter in the lowveld with irrigation. In the Highveld, sugar bean can be grown after frost occurrence.

Varietal choice
A number of varieties are available, from speckled sugar beans, for example SC Bounty and SC Sharp types to white broad beans. It is important to select the right variety for the intended market, as there are definite market preferences. The most preferred is the speckled type. Also, choose varieties that are resistant to Rust, Anthracnose, Angular Leaf Spot and Common Mosaic Virus diseases. Beans are prone to diseases transmitted through the seed, so good quality, disease-free certified seed from Seed Co should be obtained. Do not keep seed from your own crop, but rather buy in good seed each year.

Planting and crop establishment.
This depends somewhat on the variety. Short determinate varieties ought to be planted in 45 cm rows with 5 to 10 cm between plants, giving a population of about 350,000 plants per ha. Tall indeterminate varieties may be planted on wider spacings. Seed is placed about 2 cm deep.

Fertilisation.
Beans are sensitive to acid soils, so lime is required if the pH is less than 5.3. Beans are efficient users of residual fertiliser but nevertheless they do respond to applied fertiliser, especially if the soil is inherently fertile. Beans may be fertilised with manure or low rates (200 to 350 kg per ha) of a compound fertiliser (e.g. 7.14.7). A light top dressing with 100 kg/ha with a 28-34% N fertiliser (e.g Ammonium Nitrate) just before flowering may also be required if the leaves are pale in colour.

<table>
<thead>
<tr>
<th>Plant spacing for beans sown on 45cm rows:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
</tr>
<tr>
<td>Speckled (SC Sharp/Bounty)</td>
</tr>
<tr>
<td>Speckled (SC Sharp/Bounty)</td>
</tr>
<tr>
<td>Speckled (SC Sharp/Bounty)</td>
</tr>
<tr>
<td>Speckled (SC Sharp/Bounty)</td>
</tr>
</tbody>
</table>
Plant spacing for beans sown on 50cm rows:

<table>
<thead>
<tr>
<th>Type</th>
<th>In-row Spacing (cm)</th>
<th>Plant Population (Plants/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speckled (SC Sharp/Bounty)</td>
<td>10</td>
<td>200 000</td>
</tr>
<tr>
<td>Speckled (SC Sharp/Bounty)</td>
<td>8</td>
<td>250 000</td>
</tr>
<tr>
<td>Speckled (SC Sharp/Bounty)</td>
<td>6</td>
<td>333 000</td>
</tr>
<tr>
<td>Speckled (SC Sharp/Bounty)</td>
<td>4</td>
<td>500 000</td>
</tr>
</tbody>
</table>

Diseases
Rust is a common disease, which initially shows itself as small yellow-white lesions (spots) on the older leaves. These enlarge and become reddish-brown. Most of the older varieties are susceptible to rust, but usually the newer varieties have some resistance. Several fungicides are registered for control of rust (e.g., Mancozeb and Triadimefon e.g. Shavit). These may be applied either as a preventative spray or when the disease is first seen. Generally, several sprays are required at intervals of 7 to 14 days. A number of other diseases are also common, such as Angular Leaf Spot (a fungus disease common on speckled beans), Anthracnose (fungus), Common Blight (bacteria), Halo Blight (bacteria), and Bean Common Mosaic Virus. Some of the fungal diseases may be controlled with appropriate chemicals, but for the other diseases, clean seed, crop hygiene and crop rotation is important for control. Avoid walking through wet crops.

Pests.
The bean fly often causes serious problems in dry bean fields. The larva of the fly mines from the leaf down into the stem, causing the stem near the soil to swell and crack and eventually break. Crop rotation may limit the damage, while sequential planting of bean crops in adjacent fields should be avoided. Diazinon may provide some control if applied at 3, 6, 13 and 20 days after emergence. A number of other pests may attack beans, such as aphids, blister (CMR) beetles, chafer beetles, stink bugs, and boll worms. Chemicals are available for the control of these.

Harvesting.
When the pods are almost dry, but before they shatter, cut plants and wind-row. Thresh when fully dry. If the grain is being kept for home consumption, treat appropriately to avoid infestation with bruchids and weevils.
COWPEAS (NYEMBA) PRODUCTION
Cowpeas are an ideal dryland crop (pulse) in low rainfall areas because they are drought resistant and provide excellent human nutrition and good rotational benefits. They are also an intercropping crop under maize.

Soils.
Cowpeas may be grown on a wide range of soils, but they are somewhat sensitive to acid soils. Cowpeas are legumes and may be grown on their own (sole cropping) or inter-cropped with maize. It is important to grow cowpeas in rotation with other crops in order to help control diseases.

Varieties.
There are two basic types of cowpeas: upright, bunch types, used mainly for grain production; and spreading types, which may be used for grain, vegetable or fodder. Improved cultivars, e.g., IT18, are ideal for grain production, and mature quickly. Purchase fresh seed regularly to avoid build up of seed borne diseases.

Planting and crop establishment.
Plant cowpeas anytime from the first rains until the end of December. In high rainfall areas, plant cowpeas late to avoid diseases when the crop reaches maturity. When grown on their own, the following plant populations should be achieved: Spreading types: 60 000 plants per ha (12 to 15 kg seed per ha). Upright, bunch types: 120 000 plants per ha (30 to 50 kg seed per ha).

The row width may by 45 to 90 cm. Closer rows may be used for upright, bunch types, while wider rows may be used for spreading types.

<table>
<thead>
<tr>
<th>Cropping system</th>
<th>Plant type</th>
<th>Spacing (cm)</th>
<th>Seed rate (kg/Ha)</th>
<th>Populations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sole crop</td>
<td>Bushy</td>
<td>45 x 15</td>
<td>40-50</td>
<td>150 000</td>
</tr>
<tr>
<td></td>
<td>Spreading</td>
<td>75 x 20</td>
<td>20-25</td>
<td>67 000</td>
</tr>
<tr>
<td>Intercropping</td>
<td>Bushy</td>
<td>180 x 15</td>
<td>10-15</td>
<td>37 000</td>
</tr>
<tr>
<td></td>
<td>Spreading</td>
<td>180 x 30</td>
<td>5-10</td>
<td>18 500</td>
</tr>
</tbody>
</table>

Fertilisation.
Cowpeas will respond to manure or low rates (100 to 200 kg per ha) of a compound fertiliser. (E.g 7.14.7).

Diseases.
Cowpeas are susceptible to a wide range of diseases. Virus diseases may be devastating. The best control measure is through the use of virus-free seed produced under strict roguing production systems (i.e., removing and destroying any plants showing virus disease symptoms).
**Pests.**
Pests include Aphids, Heliothis bollworm, CMR beetle and Tip-wilte. After harvest, the seed is susceptible to bruchids, a grain borer. These pests may be controlled with appropriate chemicals.
WHEAT PRODUCTION

Soils and climate.

Wheat is a temperate crop and is best grown in winter under irrigation with optimum day temperatures of between 15 – 20°C and cooler nights giving the best yields. There are some varieties that may be grown in summer (such as Sahai), but generally there is high disease and weed pressure in summer accompanied by warmer temperatures that result in depressed yields (≤ 3t/ha), therefore, winter is the best time for growing wheat.

The crop is adapted to a wide range of soils. The soils must be well drained with an optimum pH range of 5.5-6.5 on a Calcium Chloride scale. Wheat yields are greater in the highveld (>1200 masl (metres above sea level)) and middleveld (900 – 1250 masl) with yield potential of 8 to 12 t/ha compared to the lowveld (<900 masl) where yields average of 4.5-7 t/ha under good management.

Varietal choice.

New varieties are continuously produced for wheat production because of the threat of disease (especially Leaf Rust and Powdery Mildew). The varieties from Seed Co, ideal for bread making, are short statured, disease resistant and well adapted to winter production. Current varieties include SC Nduna (White seeded), SC, SC Sekuru (Red seeded), SC Smart (Red seeded) and SC Stallion (red seeded), Sky (Red seeded), Select (White seeded), Serena (White seeded). SC Sahai is a summer variety which can be planted in mid-summer, around January.

Land preparation and soil conditioning

The most suitable soil for wheat is one with:
- A good effective depth with a fine tilth to ensure seed-soil contact. Good seed-soil contact ensure good crop emergence and stand which are the basis for good yields
- Favourable physical properties: good internal drainage, an optimal moisture regime,
- Chemical properties: sufficient and balanced quantities of nutrients (NPK and other micro-nutrients/trace nutrients)
- Biological properties: good level of organic matter, and with beneficial micro-organisms

The objective of soil tillage is to maintain the existing structure of soil or to improve the structure of poorly structured soils as well as addressing the three properties as mentioned above (physical, chemical and biological).

Soil conditioning

- Lime can be applied if required to ‘sweeten’ acidic soils to the pH optimum range. Lime application should be based on soil analysis prescriptions.
- Gypsum improves soil physical structure i.e. removes hard setting clodiness, removes surface crusting and poor workability as well as supplying the soil with complimentary Calcium and Sulphur for good crop standing and growth.

Tillage procedures

There are several options of tillage which fall under two broad categories: conservational and conventional tillage which can be adopted in wheat production. The conventional tillage procedure follows the following steps:
- Deep ploughing (ripping or chisel plough), liming and basal fertilizer application, discing and then followed by rolling. A roller can be pulled concurrently behind a disc harrow. Conservational tillage also known as zero/minimum tillage is another cheaper and more sustainable option which farmers can adopt.
**Time of Planting.**
The optimum time for planting winter wheat is between mid-April and the last week of May and even earlier in the Lowvelds. Sometimes planting time can be extended to mid-June but not normally recommended. Delayed planting results in a loss of about 50kg/ha/day after May. The first two weeks of May tend to give the best yields in the Highveld areas. Adhering to the optimum planting time has some agronomic explanations and rationales:

- Early summer rain escape. Rains which come after the wheat has reached physiological maturity causes sprouting (grain germination in the ear) and result in down grading of the wheat due to a decline in baking qualities.
- Disease escape - disease pressure especially for rust diseases, normally rises when temperatures start to warm up around August and an early planted crop would have gotten a good head start without disease pressure.
- Pest escape - likewise pest pressure such as aphids start to rise when temperatures start to rise. An early planted crop will have a good head start ahead of pest pressure.
- Early planting will result in early harvesting around September. One of the key considerations for the adoption of double cropping is early planting and early harvesting for both summer and winter crops. The farmer will come in with his summer crop on time when wheat is planted and harvested early. Generally, wheat takes about 125-140 days to physiological maturity depending on variety, altitude and weather conditions. The higher the altitude, the longer the time from planting to maturity.
- Wheat critical stages such as crop establishment, tillering, flowering and grain filling will coincide with the optimum growth conditions when the crop is early planted. For instance, for robust tillering i.e. for the plant to produce secondary stems (4 – 5 weeks after crop emergence) requires very cool conditions that normally occurs in May and June while Flowering (60 - 90 days) and Grain filling (> 90 days) must not coincide with frosty conditions to avoid crop sterility.

**Seeding Rates.**
The optimum plant population for wheat is 220-250 plants per m². Seed rate depends on the seed size, germination percentage, planting conditions and planting method. To achieve optimum population density, a seeding rate of about 110-125 kg/ha when drilling and 125-135 kg/ha when broadcasting with a vicon spreader is recommended. To ensure good crop standability and yield, farmers should adhere to these optimum population densities. Diseases such as Powdery mildew are also minimized with good agronomic practices.

**Irrigation requirements and scheduling**
Since there is very little or no rainfall during winter in Zimbabwe, irrigation is required to achieve a high yielding wheat crop. The total gross amount of water required is between 450 and 600 mm per ha (i.e. 4.5 - 6 mega litres per ha) depending on method of irrigation (Overhead irrigation with sprinkler or use of Centre Pivots) and must be applied as the crop requires it. The key points are:

- the soil must be brought to field capacity to the full potential rooting depth (about 1,2 m) at planting to emerge the crop;
- a light irrigation must be applied at the 4th or 5th day after sowing, to break the crust to ensure good crop emergence;
- a light irrigation must be applied at 14 to 17 days after emergence to stimulate crown root development and tillering, and;
- irrigation thereafter must be applied to match crop water use. On sandy soils with low water holding capacities, irrigate frequently (7 to 9 day cycles with 30-35mm net). On clays and sandy clays, with good water holding capacities, irrigation may be less frequent with larger amounts (10 to 14 day cycles with 40-45 mm net). This is a general irrigation scheduling guide. For an
informed irrigation scheduling, the use of a soil auger to evaluate the soil water content ahead and behind the irrigation line is a good aid to irrigation management. Irrigation is terminated when the neck of the ears/spikes/head (peduncle) turn yellow i.e. physiological maturity.

- **Crop hardening**
  After the crop has emerged, the hardening stage begins. This induces crown root development as well as tillering. The recommended hardening period (irrigation is temporarily terminated during this stage) is 10 and 14 days in light and heavy soils respectively.

- **Top dressing** fertlizer and herbicide application is done after a light irrigation which follows the hardening period, normally about 21 days after emergence.

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**Fertilisation.**
The fertiliser regime management in wheat, like any other crop must be tailored to the soil fertility status, the yield potential and the grain quality requirements. As a general guide, wheat requires a basal application of 300 to 500 kg/ha of a compound fertiliser (such as 7-14-7) and a top dressing of 350 to 500 kg of Urea or Ammonium Nitrate per ha. Both fertilizer dressings are broadcast by a vicon.

Generally, 160 -190kg/ha of Nitrogen Units (N), 50 - 70 units of Phosphorous (P) and 30 – 50 units of Potassium (K) are adequate for optimum plant growth. Basal fertilizer need incorporation into the soil by discing and should be applied after primary tillage. The top dressing is usually applied in one application between 14 – 21 days after emergence on heavy soils, and in two applications of equal amounts at 14 and 35 days after emergence on sandy soils. Top dressing should be applied after the hardening stage. Top dressing is essential for good leaf and general plant growth and ultimately the yield but also importantly for attaining good protein levels. The minimum protein level requirement for “Premium” (Good quality) wheat is 11%. It is one of the considerations for grading and pricing of wheat. Attainment of good protein levels is also determined by varietal choice and general management. Application of Nitrogen after flowering can also boost the Grain Protein Content of wheat.

*All fertility management practices must be based on proper full soil analysis recommendations by approved laboratories.*

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**Weed control**
Farmers are advised to use some wheat specific post-emergence herbicide which should be applied after a light irrigation which follows the hardening period (2 WACE-Weeks After Crop Emergence). We also recommend farmers to apply specific herbicides against volunteer crops. Puma super is normally sprayed when wheat is planted after a maize crop against maize volunteer plants. For soya volunteers, a herbicide called ally is recommended. Banvel and MCPA combination covers a wide spectrum of broad leaf weeds and is recommended.

*It is important for farmers to read labels whenever they are applying herbicides.*

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**Pests and diseases.**
Aphids and stalk borers can attack wheat with aphids coming in earlier soon after tillering while borers can attack the plant from flowering onwards. Farmers must also be on the look-out for “Fall armyworm” given that wheat is one of the host crops to the pest. These pests can be controlled with appropriate pesticide sprays after scouting.

During the late grain-filling period, Quelea birds may consume much grain and reduce yields significantly if not attended to. A pesticide molecule called 9,10-Anthraquinone 50% WP (Bird Shield) has been developed, which can be used as a seed dressing or as a foliar spray at soft dough stage. Efficacy of this pesticide molecule can be enhanced by applying with a sticker and also a rainfast period of 4 hours or more. This pesticide molecule will act as a bird repellent. This is the best and the most efficient option. The other option is bird-scaring using bells, tins, whistles, discs/reflectors etc. by bird scaring gangs.
Diseases such as Leaf rust, Stem rust, Powdery mildew, Fusarium head blight and Take-all may cause yield reduction. Farmers must seek professional advice on how to control these diseases. The best bet is for farmers to grow resistant varieties and Seed Co wheat varieties such as SC Select are resistant to these diseases. Generally two preventative fungicide sprays are recommended if farmers are located in disease prone areas and gives some form of insurance against climate change that can result in new disease pathotypes.

NB: Farmers are encouraged to scout their wheat crop for diseases, pests and deficiencies and make spraying decisions early when pest/disease reaches economic threshold levels. Consult Agrochemical companies for more information on chemicals. Always read chemical labels carefully, use safe practices and adequate protective gear during application.

Wheat production: General tips:

1. **Plan ahead:** evaluate available water resources in order to calculate wheat area based on proposed gross application. Irrigation equipment and infrastructure must be ready, with checks made on pumping unit, conveyance system, pivot, sprinkler condition and nozzle wear.

2. **Soil condition and fertilisation:** Soil sampling is always the starting point in determining the rates and types of soil conditioners and fertilisers to be used.

3. **Start at Field capacity:** Crop emergence requires a soil profile that is at field capacity down to the full potential of the rooting depth. This should be achieved by the 3 – 4 leaf stage, at the latest. This is important because wheat roots grow downwards at a rate of 20 – 30 mm/day and any dry layers within the profile will impede root growth and proliferation.

4. **Establishment irrigation:** Seed germinates happily in the presence of good soil moisture. Establishment irrigations need to be geared to achieve a uniform and adequate stand, and this depends on planting method and uniformity of irrigation. Drilled seed normally requires one good irrigation to cause germination because of good soil-seed contact. Broadcasted seed or zero tillage fields, require frequent (2 – 3 day intervals) light irrigations (25mm) to effect establishment. A light irrigation is essential (4 – 7 days after the first irrigation) in soils that are prone to crusting to assist with emergence.

5. **Ensure crown root development and tillering:** At 3 - 4 leaf stage (14 – 17 days after the first germination irrigation), crown roots and the ear begin to develop and tillers start growing. Water deficit adversely affect these processes yet they play an important role in yield formation. At this stage, usually the top 100 – 150mm of the soil is dry and crown roots will not grow into dry soil. It is necessary to apply a light irrigation to stimulate crown roots and tillering. It is also an appropriate time to top dress the wheat with Nitrogen fertilizer.

6. **Initiate an irrigation schedule early and monitor the soil and crop through to maturity:** Scheduling assist the manager to monitor crop progress and thereby ensure the best treatment possible is given to the crop. Assess soil and crop conditions before and after each irrigation cycle to evaluate whether or not the irrigation is recharging the soil profile to the satisfaction of the plant needs. A soil auger is extremely useful in this regard. An auger test ahead of the line will show how deep the plant is drawing water while an auger test two positions behind the line will show how effective the irrigation application is in replenishing the soil. Well irrigated wheat has a dark green colour, soft large leaves and many tillers, whilst “stressed”wheat has a bluish colour, hard, spikey leaves which may also roll up in some varieties, and a few tillers with small ears.

7. **Crop maintenance:** Weed, disease and pest control are important in achieving a good crop.

8. **Timing of the last irrigation:** There is no point in irrigating a yellowing crop and grains are fully formed and after hard dough stage. Full maturity is reached when the peduncle (neck, area below the ear/spike) turns yellow. Irrigation applied during later grain-fill or during grain dry down is of no value to the crop and may even reduce the quality of the grain. Water after ripening may cause pre-harvesting sprouting (germination in the ear) leading to down grading of wheat due to reduced grain quality.
9. **Keeping irrigation records:** It helps to plan future irrigation practices. Useful records include:
   - (a) Water usage with a flow meter
   - (b) Energy use, either electricity units or diesel litres
   - (c) Dates and amounts of irrigation applied
   - (d) Evaporation and air temperature
   - (e) Labour

**Centre pivot-irrigation scheduling-a general guide.**

Generally center pivot irrigation is the simplest method of irrigating any crop. For efficiency, there are factors to consider when using center pivots. It is proven that a farmer gets more effective water application on a fixed center pivot as compared to a towable pivot. This is largely due to the fact that there is run down time loss due to towing from one center to the other.

It is advisable that when using a fixed center pivot anything between a 10mm and 12 mm spray package is recommended. However if it is a towable center pivot and a farmer intends to do two circles with one pivot a bigger spray package is more ideal for the pivot and this can be from 14 mm to 20 mm spray package depending on specific requirements. A bigger spray package is recommended for towable center pivots to reduce the turnaround time of the center pivot to avoid moisture stress in the other circle.

For easy water application, a farmer is advised to run their pivot in **WET** mode. The wet mode allows the operator to program the pivot to apply the exact amount of mm required at the particular stage of growth of the crop. In instances where the pivot is run in dry mode the operator will be required to calculate the percentage on the timer which corresponds with the amount of water (mm) that need to be applied and in most cases errors on calculation are sometimes common and a farmer will not achieve the intended spray volumes. It is advisable then that farmers should ask their centre pivot service provider to program the machine to work in the wet mode.

**Chemigation/fertigation calibrations guide.**

Calibration factors that need to be considered when using a centre pivot for chemigation and fertigation include the sizing of the dosing pump and its pumping rate. Always ensure you discuss with your pumps specialist before purchasing a dosing pump for correct dosing pump sizing for your applications as applications vary from case to case. It is also important that your fertigation or chemigation unit is as close as possible to the centre pivot inlet as possible generally not more than six metres. Below are critical factors to be considered when using a pivot for both chemigation and fertigation.

1. Length of the pivot to the edge of the effective wetted area
2. Length of the pivot to the last tower
3. Last tower travel distance in a given amount of time running at present application. This point has to be verified physically by the farmer with the pivot running in wet mode at the present application rate. Do not rely on literature or your pivot control panel as other factors such as terrain (e.g. slope/gradient) can affect your last tower run speed-so this must to be verified.
4. Targeted product application rate in kgs/litres per hectare
5. Product concentration in kgs/litres per m$^3$ of active ingredient
6. Percentage of a full circle centre pivot that will be used during the application

**Harvesting.**

On a large scale, wheat is usually harvested by combine, but it is possible to hand harvest and thresh small areas of wheat. Combine harvesters must be set carefully and operated according to Service Manuals in order to keep harvest losses to a minimum.
FIELD EMERGENCE DIAGNOSTIC GUIDE

All Seed Co seed is sold by lot number and meets the minimum standards of government regulations for either certified or standard grade seed. The minimum germination standards for certified seed are 90% for maize, 75% for soyabean, 70% for groundnuts, 85% for wheat and 80% for sorghum. The lot number identifies the seed source. It is always a good idea to keep a record of seed purchased, including date and place of purchase and the lot number. This will help in the event of a field emergence problem.

Correctly planted seed under ideal germination conditions should emerge after 6 days. In the event that there is no emergence or uneven emergence after 6 to 10 days, follow the guide below as an aid to identify the likely cause.

1. Dig up sections of the rows planted; look for the original seed and note any unusual things.

2. If there is no seed present where you would expect to find it; consider the following:
   - Planter blocked?
   - Low seed rate?
   - Uneven spacing in the row?
   - Seed eaten by pests/birds?
   - Seed stolen?

3. If seed is present, but no root or shoot visible:
   3.1. If seed is dry and healthy
   - Insufficient moisture for germination
   3.2. If seed is swollen and alive
   - Cool temperatures? Insufficient moisture? Delayed moisture?
   3.3. If seed is swollen, but dead and rotten
   - Water logged soil?
   - Insufficient moisture? Very hot or cold soil? Seed diseased?
   - Poor seed/soil contact?
   - Poor seed storage conditions resulting in dead seed?
   3.4. If seed is damaged, eaten or cracked
   - Soil pests?
   - Mechanical damage from planter?

4. If seed is present, with germination proceeding (i.e. root & shoot emerging)
   4.1. Normal vigour, but slow emergence
   - Cool temperatures? Deep planted?
   - Insufficient moisture at planting?
   - Capping/surface crust/cloddy soil?
   4.2. Low Vigour or distorted growth: Old seed?
   - Poor seed storage?
   - Cold temperatures?
   - Fertiliser burn?
   - Herbicide or Pesticide damage?
   - Capping/surface crust/cloddy soil?
A CROP DOCTOR
A crop doctor is a farmer who takes time to investigate his fields in order to prevent problems and improve productivity. He walks his fields regularly, observing, thinking, inspecting and evaluating. He diagnoses problems and seeks solutions.

Here are some tips on how to be a crop doctor:

- Take with you a small hoe or spade, a knife, a notebook and pen. Walk through your fields in a random manner, stopping every now and then to examine the soil, plants and surrounds. Be observant, be an investigator, think, take notes.
- Examine at least ten places in the field when taking a general inspection, but if scouting for pests it may be necessary to examine between 24 and 100 plants, depending on the pest and the size of field.
- Consider the recent weather patterns. How has the weather been for crop production? Has it been hot and dry, cold and wet, or overcast? How may this have affected the crop?
- Look at the soil and roots. Dig into the soil, and ask questions to yourself: Are the roots shallow, deformed, or normal? Is the soil dry or wet? Is there a crust, compaction or impediment? Are there any pests in the soil?
- Study the crop plants. What was the planting date? Is the plant spacing correct? Are the plants evenly spaced? How many leaves are on the plant? Do the plants look healthy? When and how was the fertiliser applied? What pests and diseases can you find? Are the leaves being eaten? Is there any lodging? How long before harvest? Pull up a plant, cut open the stem,
- and look to see if there is anything unusual. Pull open the flowers, pods or cobs; what do you find? Are they normal, or are there problems?
- Weed control. Can you identify the weeds? Are they too numerous? How and when are you going to control the weeds? Did the herbicide work? If no, why not? If you are hand weeding, how long before the field will be finished?
- Pest and disease control. Do the pests or diseases need to be controlled? How will you do this? Was the last pest or disease control measure effective? If not, why not?
- Make plans. What is the most important thing to be done in each field? How and when are these going to be done?

Matter of fact: The best fertilizer is the footmarks of the farmer in the field!

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