Growing Green Maize on Canal Schemes in Vhembe: PRODUCTION GUIDELINES

W van Averbeke, K Ralivhesa, S Mbuli,
TB Khosa & KW Manyelo

WATER RESEARCH COMMISSION
TT 567/13

Growing Green Maize on Canal Schemes in Vhembe: Production Guidelines

Report to the
Water Research Commission

by

W van Averbeke, K Ralivhesa, S Mbuli, TB Khosa & KW Manyelo
Centre for Organic and Smallholder Agriculture
Department of Crop Sciences
Tshwane University of Technology, Pretoria

WRC Report No. TT 567/13
August 2013

Obtainable from
Water Research Commission
Private Bag X03
Gezina, 0031

orders@wrc.org.za or download from www.wrc.org.za

The publication of this report emanates from a project titled *Improving livelihood and scheme productivity on smallholder canal irrigation schemes in the Limpopo province (WRC Project No. K5/1804//4).*

This report forms part of a series of four reports. The other reports are:

- Improving Plot Holder Livelihood and Scheme Productivity on Smallholder Canal Irrigation Schemes in the Vhembe District of Limpopo Province (WRC Report No. TT 566/13)
- Production Guidelines for Small-Scale Broiler Enterprise (WRC Report No. TT 568/13)
- Guidelines on Management of Working animals (WRC Report No. TT 569/13)

ISBN 978-1-4312-0445-8
Printed in the Republic of South Africa

Acknowledgements

The authors are indebted to:

- Dr M Barrow of PANNAR Seed, for the helpful advice and the provision of maize seed that was used in some of the green maize experiments on which these guidelines are based.
- Professor MC Laker for reviewing the draft guidelines and for providing useful suggestions for their improvement.

Any errors or shortcomings that remain in these guidelines are entirely the responsibility of the authors.

Comments, suggestions and questions on the content of these guidelines are most welcome. Please send your contributions to:

Wim van Averbeke

Department of Crop Sciences
Tshwane University of Technology
P Bag X680
Pretoria 001 or
vanaverbekew@tut.ac.za or
vanaverbekew@gmail.com

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Why green maize?

Green maize, also known as ‘maize on the cob’, ‘table maize’, ‘green mealies’ and ‘garden maize’, is a healthy and popular snack in South Africa. In towns and cities around the country, green maize is boiled and sold as a ‘takeaway food’ by street traders. It is also sold uncooked, usually by ‘bakkie traders’ in bundles of four to six cobs, for preparation at home.

For farmers, growing maize for marketing as green maize is attractive, because the value of green maize is higher than that of maize grain. For example, in February 2012, a large cob (containing about 350 g of dry grain) that was sold as grain provided an income to farmers in Vhembe of about R0.77. That same cob sold as green maize gave them an income of R2.00, which was about 2.5 times more money for the same-size cob. Moreover, green maize is harvested at least one month before the grain reaches maturity (black layer), and then there is also the time that the grain cobs are left in the field to dry. Accordingly, growing maize for green-cob harvesting frees up land for the next crop sooner than when the crop is grown for grain. Obviously, this particular advantage does not apply when plants with cobs that were not sold green are left in the field to mature for harvest of the grain.

Farmers can only realise the high income from selling their maize as green cobs when someone is prepared to buy the cobs. In Vhembe, much of the green maize is bought by street traders (Plate 1). These are mostly women who buy a bag of cobs a day and boil the maize at home to sell in town (Plate 2). For this reason, it is important that farmers first establish that there are traders around who would be interested in buying their cobs before they start growing green maize.

Street traders apply certain quality criteria when they purchase green maize cobs. In Vhembe, street traders enter farmers’ plots and harvest only those cobs that they believe they can sell to their customers. The cobs they buy are large, completely filled

with kernels and free of damage by insects or birds (see Plate 3). As a result, not all the cobs in a stand are purchased by street traders. Depending on how many cobs are left in the stand, one must decide to sell at a discount (some traders are open to negotiation), to consume the remainder at home and use them as gift to neighbours, or to leave the plants growing and harvest the cobs for grain. When the plants are left in the field, the advantage of freeing up your land earlier for the next crop disappears.

PLATE 1: Street trader buying green maize from a farmer at Dzindi

PLATE 2: Street traders loading bags of green maize cobs in a bakkie to take home, boil and sell later in the day at Thohoyandou

PLATE 3: To be marketable as green maize, cobs must be large, completely filled with kernels and free of damage by insects or birds

Farming on an irrigation scheme presents an important advantage to farmers, because green maize can be produced outside the rainy season. During the rainy season, many people in Vhembe grow maize in home gardens, fields and even on open spaces along the road. When this maize gets ready for harvest as green cobs, towards the end of December and during January, the demand for green maize drops declines, whilst supply increases. Traders tend to be very picky when you market your green maize during that time and often they only harvest the very best cobs. For this reason, it is advisable to plant your maize so that it will be ready for marketing when there is no competition from dryland farmers.

1.2 Does growing green maize differ from growing maize for grain?

When maize is well supplied with water and nutrients and is spaced far apart, the plants will produce large cobs, sometimes more than one, but because the number of plants per unit area is low, the grain yield is not very high. When maize is spaced closely, the plants produce small cobs, but because there are many plants per unit area, the grain yield is higher than when the plants are spaced far apart. So, when growing maize for grain, the crop must be spaced closely. When the crop is grown for green maize, cobs must be large. As explained earlier, large cobs are obtained when the plants are spaced far apart. In field experiments at the Dzindi canal scheme in Itsani near Thohoyandou excellent production of green maize was achieved when the maize plants were spaced 0.60 m apart in the rows, using a row spacing of 0.75 m, which is the common row spacing on canal schemes in Vhembe. The resulting planting density was 22 222 plant ha^{-1} or 2.22 plants m^{-2}. Planted in August or September at this particular spacing and using the cultivar SC701, every maize plant produced a cob that was large enough to be sold as green maize. Selling at R2 per cob, the gross income obtained was R4.44 per m^{-2} or R44 444 ha^{-1}. Even the best grain farmers in South Africa will struggle to achieve a gross income as high as this! Obviously, the money earned from sales is not all profit. From the cash received the input costs have to be deducted. At the end of

these guidelines, an green maize enterprise budget is presented for a 1000 m^2 plot, which is more or less the size of a single strip (farmers call it a bed) on a canal irrigation scheme.

1.3 How were these guidelines compiled?

The information contained in these guidelines was obtained by conducting field experiments at Dzindi Irrigation Scheme in Itsani near Thohoyandou over many years. These experiments were done by a team of students and field assistants in collaboration with local farmers. Baldwin Khosa identified the best cultivar and plant spacing when planting green maize at different times of the year. Katutshelo Ralivhesa investigated choice of maize cultivars, planting date and maize streak virus and Sibonelo Mbuli established best irrigation practices when growing green maize on canal schemes. Kgabo Manyelo studied the trade of green maize. All of these students were guided by Wim Van Averbeke of the Centre of Organic and Smallholder Agriculture at the Tshwane University of Technology in Pretoria.

1.4 What can I learn from these guidelines?

These guidelines have been compiled to guide you, the Vhembe canal irrigation farmer, with your decisions on planting date, cultivar, plant spacing, fertiliser application and plant protection. It also gives you information on the input costs and the income you can expect from green maize production, provided you are able to sell all your cobs as green maize. The information on costs and income were collected during January 2013. As you know, prices change all the time, and you should update the enterprise budget presented in these guidelines before you make your decision to grow green maize.

1.5 Do the guidelines apply to Vhembe canal schemes only?

The information contained in these guidelines applies specifically to the production of green maize on canal schemes in Vhembe but some of it can be used in other areas including schemes where overhead irrigation (sprinkler, floppy or centre pivot) is used.

The information on planting date and cultivar selection is particular to Vhembe and cannot be transferred to other areas, because the climate in Vhembe is subtropical (no frost). In many other parts of South Africa the climate is colder and frost occurs during winter. As a result, conditions are very different from those experienced in Vhembe. Since maize is sensitive to frost, it can only be grown during the frost-free part of the year. The rate of growth and development of a maize plant is also dependent on temperature. Up to a temperature of 30^{o}C, the growth rate goes up as the temperature increases. Below 10^{o}C, maize plants do not grow.

The information on short-furrow irrigation, which is the norm on canal schemes, is also specific. When using overhead irrigation, there is no need to create ridges in the strips or plots and when the risers are properly spaced, water distribution in the field should be fairly uniform. The same applies to drip irrigation, as long as each plant is served by a dripper and all drippers have similar delivery rates (volume of water per unit time). The delivery rate of drippers can be tested by placing containers under selected drippers along the full length of the dripper line and by checking that none of the drippers are blocked.

The other agronomic information as well as the financial and market information contained in these guidelines are not really specific and can be applied by farmers throughout South Africa.

2 GUIDELINES FOR GREEN MAIZE PRODUCTION

2.1 Choosing a suitable planting date and cultivar

Many parts of Vhembe are frost-free and warm enough to plant and grow maize all year round. At present, farmers in Vhembe avoid planting green maize from January until about May, because maize planted during this period gets badly affected by maize streak virus. When maize is infected with the maize streak virus the leaves of the plant develop a striped pattern (Plate 4). Depending on time and severity of the infection, plants produce small cobs or no cob at all.

PLATE 4: Alternating yellow and green streaks that run along the veins of maize leaves indicate that the plant has been infected with the maize streak virus

When maize is planted from June to December, the incidence of maize streak virus is much less. Obviously, farmers who would risk planting from January to May and grow the crop successfully would be in an ideal position to market their cobs, because no one

else has green maize for sale when their crop is ready for harvest. When stands planted during these months are harvested by traders, they compromise more readily on cob size than during other periods of the year, when supply is more abundant.

One can grow green maize using a wide range of cultivars. In Vhembe, consumers do not insist that the grain must be white but in other parts of South Africa, white grain is a requirement. At Dzindi we tested several cultivars and found SC 701 and ETZ 200 to be best suited, because they produce large cobs with white grain. PAN 67 was the best cultivar during the period of the year when maize stands were most susceptible to the maize streak virus.

The maize streak virus is transmitted mainly by a particular type of leafhopper. This insect flies from maize plant to maize plant and sucks the juice, just like mosquitoes suck blood from people. Whilst sucking juice the leafhopper infects the maize plant with the maize streak virus. One way of managing the spread of this disease is to treat the seed before planting with Gaucho® but this is expensive. Gaucho® makes the juice of the maize plant poisonous to insects and when they suck the juice they die. This prevents them from infecting other plants. Another way is to make use of a cultivar that is tolerant to the maize streak virus. Tolerant cultivars do get infected with the maize streak virus but the effect of the infection is reduced compared to cultivars that are not tolerant. Use of tolerant cultivars is preferred to the use of Gaucho®, because it is cheaper and does not present a health hazard to farmers and their families. PAN 67 is a maize cultivar renowned for its tolerance to maize streak virus.

Table 1 shows the risk of maize streak virus infestation, market conditions, expected yield of green maize, and the recommended cultivar when planted during the different months of the year. From Table 1 it can be seen that market conditions are best when maize is planted during the period March to June but in maize that is planted from March to May, maize streak virus infection is problematic and it is also difficult to grow large cobs in stands that were planted during these months, because of limited sun light and cool temperatures. This makes June the ideal planting date from a production and marketing perspective but the size of the cobs will still be smaller than when the crop is

planted in July. The period July to September is when most farmers on canal schemes plant their green maize. Maize steak virus is no longer a problem and growing conditions are suitable to produce large size cobs. Planting during these three months is early enough to avoid competition from dryland farmers but competition among farmers on the many irrigation schemes in Vhembe is of course fierce and becomes stronger over time, peaking among farmers who plant in September.

TABLE 1: Risk of maize streak virus infestation, market condition, expected yield and recommended cultivar when planting maize at different times of the year

Month	**Market condition**	**Risk of maize streak virus infection**	**Expected yield**	**Recommended cultivar**
January	Good	High (20-40%)	Medium	PAN 67
February	Very good	High (20-40%)	Low	PAN 67
March	Excellent	Very high (40-60%)	Very low	PAN 67
April	Excellent	Very high (40-60%)	Very low	PAN 67
May	Excellent	High (20-40%)	Low	PAN 67
June	Excellent	Low (5-10%)	Medium	SC 701
July	Very good	Very low (<5%)	High	SC 701
August	Very good	Very low (<5%)	Very high	SC 701
September	Good	Very low (<5%)	Very high	SC 701
October	Poor	Very low (<5%)	Very high	SC 701
November	Poor	Low (5-10%)	High	SC 701
December	Poor	Medium (10-20%)	Medium	SC 701

Planting maize from October to December is relatively risk free and gives large-size cobs but market conditions are poor, because of competition from dryland farmers and gardeners.

January and February are better months to plant from a market perspective but maize streak virus is becoming problematic in stands planted during these two months and cob size is declining.

To avoid an over-supply of green maize, it is not advisable to plant all your strips (beds) to green maize at the same time. Rather use a staggered approach, whereby the different strips are planted on different dates, leaving one to two weeks between each planting. For plantings in which maize streak virus is expected to be a problem (January to May), best results will be obtained when the cultivar PAN 67 is planted. For all other months SC 701 is expected to give best results, because this cultivar produces larger cobs than PAN 67. It must be noted, however, that the seed of SC 701 is considerably more expensive than the seed of PAN 67.

2.2 Preparing land for green maize production

Short-furrow irrigation is by far the most common irrigation technique used by farmers on canal schemes in Vhembe. On canal schemes located on sloping land the plots are usually divided in strips (beds) as shown on Plate 5.

The strips on canal irrigation plots run more or less perpendicular to the direction of the slope and are separated by bunds or contour banks to avoid soil erosion. Generally, as the slope of the land gets steeper, the width of the strips gets narrower. When the strips were constructed, they were also given a gentle slope away from the concrete supply furrow that transmits water from the main canal to the plots (Plate 6).

PLATE 5: On sloping land the irrigation plots are usually divided in strips, which are laid out perpendicular to the slope of the land

PLATE 6: On canal schemes water is transmitted in a concrete supply furrow (white arrow) from the main canal to the plots, where it is then diverted into the lead furrow (blue arrow), which transmits water to the different subsections of the strip

To prepare a strip for short-furrow irrigation, the land is first ploughed, then disked and finally ridged (Plate 7).

PLATE 7: Ridging is the final operation when preparing a strip for short-furrow irrigation

The furrows between the ridges are used to apply irrigation water but these furrows are not left as continuous from the start to the end of the strip. Instead, the strip is subdivided into smaller sections, separated by hand-made ridges (Plate 8). When irrigating a strip, water enters the strip through a lead furrow (Plate 6) and is then diverted into the different subsections, one at a time, starting with the subsection closest to the concrete supply furrow and proceeding systematically towards the end of the strip.

When diverting water from the lead furrow into a subsection, the furrow farthest away from the lead furrow is irrigated first and the furrow closest to the lead furrow last (Plate 9).

PLATE 8: Strips are subdivided into smaller sections, separated by hand-made ridges (white arrows) to enable short-furrow irrigation

PLATE 9: When diverting water from the lead furrow (blue arrow) into a subsection, the furrow farthest away from the lead furrow is irrigated first and the furrow closest to the lead furrow last

The short-furrow irrigation technique was developed by canal scheme farmers and most of them know it very well, whilst new farmers learn it from their neighbours. What is perhaps less well known among farmers is that for the irrigation water to be distributed uniformly along the length of every short furrow, the soil in each short furrow should be level. Since the strips of land usually slope gently away from the concrete supply furrow, the short-furrows also tend to slope in that direction. If left unattended, this results in more water entering the soil in the bottom part of the furrows than in the top part (Figure 1). Over time, this visibly affects growth of the plants. Plants located towards the end of the furrow tend to grow better and taller than those at the front end. In green maize production, this can result in traders rejecting the cobs of plants growing near the top of the furrow because they are too small.

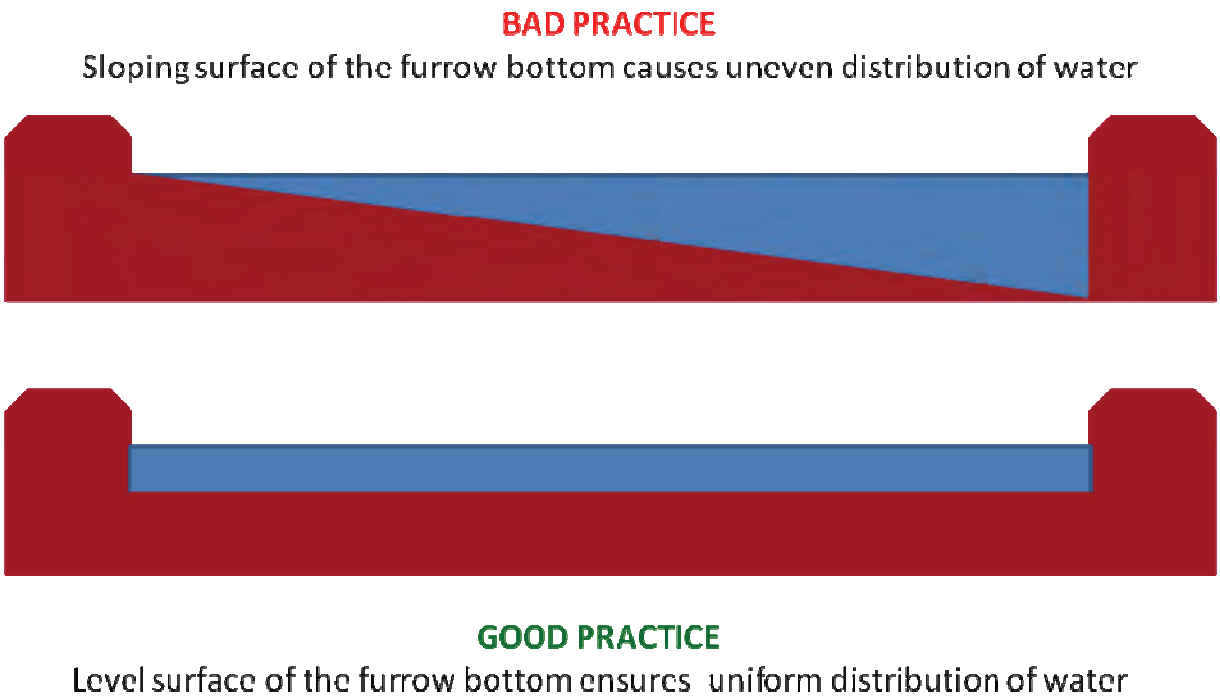

FIGURE 1: To achieve uniform distribution of irrigation water in the furrows of each subsection of an irrigation strip, the bottom of each furrow must be level

To make sure that the furrow bottoms are level, you should observe the furrows just after they have been irrigated. If the furrow bottom has a slope, water will disappear in the upper part first whilst it will still be standing in the bottom part (Figure 2). When this is observed, the bottom part of the furrow must be raised by adding soil. In furrows that are level, water will disappear into the soil at more or less the same time over the entire length of the furrow (Figure 3).

FIGURE 2: When the furrow bottom has a slope, water will disappear first in the upper part and only later on in the bottom part

FIGURE 3: When the furrow bottoms in the different subsections of the irrigation strip are level, the water will disappear (infiltrate) into the soil at more or less the same time over the entire length of the furrow

2.3 Pre-charging the soil profile with water before planting

On canal schemes the sharing of water is usually regulated by means of a time table. Typically, plot holders on canal schemes receive irrigation water once per week. At times, water shortages develop, because the river flow is low or because some part of the canal infrastructure malfunctions. For this reason, it is good practice to fill up the soil with water before planting. This is done by irrigating the strip to be planted at least three times before planting the crop (Plate 10).

PLATE 10: Applying irrigation water at least three times before planting your green maize creates a water reserve that will help to protect your crop against water stress during periods of water deficit (shortage)

One short-furrow irrigation event adds about 20 mm of water to the soil water store. This means that three irrigations will raise the water content of the soil by 60 mm, which is about 10 to 15% of the total water requirement of a green maize crop. Filling up your

soil before planting also gives you the opportunity to check that the furrow bottoms are level, and to modify them when they are not.

2.4 Applying fertilisers and planting the seed

To grow well, maize does not only need water, it also needs nutrients (plant food). Nitrogen, phosphorus, potassium and Zinc are the four nutrients that are often in short supply in soils. To ensure that your green maize crop does not suffer from a lack of plant food, you need to apply fertilisers. There are two types of fertilisers, namely chemical and organic.

Chemical fertilisers are sold in farm supply stores. They are presented as granules or crystals and are sold in bags. They contain only specified plant foods. These specified plant foods are in forms that maize and other crops can take up immediately from the soil. Chemical fertilisers are highly concentrated sources of plant food but they cost a lot of money.

Organic fertilisers are materials that consist mostly of decomposed plant material. Animal manure is the most commonly used type of organic fertiliser. Compost, obtained by rotting vegetable rests and other plant materials is another type of organic fertiliser that is widely used, particularly in home gardens. Unlike chemical fertilisers, which contain only a few different plant foods (fertiliser mixtures) and sometimes just one (single fertilisers), organic fertilisers are complete fertilisers, which contain all the different foods a plant needs but not necessary in the desired proportions. The plant availability of the different nutrients contained in organic fertilisers is also variable. For example, the phosphorus and potassium in cattle manure is more readily available to plants than the nitrogen. The concentration and availability of plant nutrients in manure also varies among the different types of manure. For example, poultry manure contains more nitrogen that cattle manure and the nitrogen in poultry manure is also more available than the nitrogen in cattle manure. That is why it is a good idea to apply cattle manure in combination with poultry manure or in combination with Limestone Ammonium Nitrate (LAN in English; KAN in Afrikaans).

2.4.1 Using chemical fertilisers

When using chemical fertilisers, we recommend that you apply 300 kg of the fertiliser mixture 2:3:4 (30)+0.5% Zn in the planting furrow and that later on you band-place additional N using three split applications of N in the form of limestone ammonium nitrate (LAN). This fertiliser strategy with gradually build the chemical fertility of your land but is not cheap. For this reason, we provide you with an alternative strategy that is less expensive but should also give you good results.

Option 1: **Band placement of 30 kg P and 40 kg K and split application of 170 kg N**

This option is ideally suited when you plant maize by opening planting furrows. The recommended quantity of the fertiliser mixture 2:3:4 (30)+0.5% Zn is spread evenly in the planting furrow and is then mixed in the soil by dragging a stick along the bottom of the planting furrow. Water is then poured (10L bucket per 10 m row) in the planting furrow. Pouring water before planting will assist germination of the seed. When the water has drained, maize seed, spaced 60 cm[1] apart, is pressed into the wet soil at the bottom of the planting furrow and the covered with about 5 cm of soil. Later on, limestone ammonium nitrate (LAN) is band-placed to supply additional N to the crop. The entire band-placed fertiliser application strategy is summarised as follows:

[1] When using 75 cm between rows (distance between the centre of adjacent furrow bottoms or ridge tops), we recommend a spacing of 60 cm between adjacent plants in the row. This will result in a plant population of 22 222 plants ha^{-1} or 2.22 plants m^{-2}. This plant population is below the optimum and as a result will allow for some factors, such as water or nutrients, not being optimally available. For planting dates ranging from June to December, you could reduce the plant spacing in the row to as low as 40 cm, which would result in a plant spacing of 33 333 plants ha^{-1} or 3.33 plants m^{-2}. When all plants in that stand would yield a marketable cob, your income per ha would be raised from R44 444 to R66 666, an extra R22 222. However, you should only consider narrowing the spacing in the row to a distance less than 60 cm when you have gained sufficient confidence in your production skills. You will have reached that confidence when at least 90% of the plants in your field yield cobs that are marketable. Using a spacing of 50 cm or 40 cm in the row increases competition among plants and makes the plants more sensitive to limiting factors. When conditions are limiting, the entire stand may fail to produce cobs that meet the quality criteria of traders. Note that you should **NEVER** space your green maize narrower than 40 cm. Also, you should only consider spacing green maize narrower than 60 cm when planting the crop during the period June to December.

1. At planting apply 300 kg ha^{-1} of the fertiliser mixture 2:3:4 (30)+0.5% Zn[2] in the planting furrow. This amounts to 225 g of the fertiliser mixture per 10 m row length.
2. When the plants are about 1 month old or 30 cm high, apply 100 kg ha^{-1} limestone ammonium nitrate (LAN) in the band. This amounts to 75 g of LAN per 10 m row length.
3. Two weeks later, apply another 100 kg ha^{-1} LAN in the band. This amounts to 75 g of LAN per 10 m row length.
4. Two weeks later apply another 100 kg LAN ha^{-1} in the band. This amounts to 75 g of LAN per 10 m row length.

Option 2: Spot application of fertiliser mixture and nitrogen

This option saves you quite a bit of money because less fertiliser is applied but it requires more work and does not increase the overall fertility of your field. When using spot application, you open a small hole of about 10 cm deep at every planting station using a hand hoe, a garden trowel or any other tool that is suitable for this purpose. You fill the plastic cap of a cool drink bottle with the 2:3:4 (30) + 0.5% Zn fertiliser mixture and pour it in the hole. Mix the fertiliser granules with the soil then cover them with a layer of soil of about 5 cm. Poor a cup of water (250 mL) in the hole and when the water has drained, press the seed in the wet soil and cover it with about 5 cm of soil. The entire band-placed fertiliser application strategy is summarised as follows:

1. At planting apply one plastic bottle cap (about 3.5 g) of 2:3:4 (30) + 0.5% Zn fertiliser in a 10 cm deep hole at each planting station.

[2] Potassium (K) is an expensive nutrient when purchased in chemical form. With the exception of maize grown on leached sandy soils, which can be deficient in K, maize in South Africa rarely responds (showing an increase in yield when K is applied) to the application of potassium (K). The fertiliser mixture 2:3:4 (30) +0.5% Zn is rich in K. We recommended its use in these guidelines because it supplies all the K that will be removed by maize from the soil. In this way the K reserve in the soil, which is usually considerable, is not affected. Over the medium to long term (5 to 10 years) we do not expect any negative effects from eliminating K from the starter fertiliser applied at planting in the band. This could be achieved, for example, by applying mono-ammonium phosphate (MAP) + Zn instead. When applying MAP in the band, us a rate of 175 kg MAP ha^{-1} or 132 g per 10 m row.

2. When the plants are about 1 month old or 30 cm high, apply 1 one plastic bottle cap (LAN) in a hole about 10 cm to the side of each plant and cover with soil.
3. Two weeks later, apply another plastic bottle cap (LAN) in a hole about 10 cm to the side of each plant and cover with soil.
4. Two weeks later apply another plastic bottle cap (LAN) in a hole about 10 cm to the side of each plant and cover with soil.

Use of **option 1**, requires you to apply 6 bags of 50 kg fertiliser mixture 2:3:4 (30) + 0.5% Zn and 6 bags of 50 kg LAN per ha.

Use of **option 2** requires you to apply 1.5 bags of 50 kg fertiliser mixture 2:3:4 (30) + 0.5% Zn and 1.5 bags of 50 kg LAN per ha, which is one quarter of the amount of fertiliser used in the case of option 1.

2.4.2 Using animal manure

When you have access to animal manure, you could replace chemical fertilisers partly or completely with this resource. Different options are discussed.

Using cattle kraal manure and LAN

Our fieldwork at Dzindi shows that spreading 10 to 12 tons of cattle kraal manure supplies all the P and K needed by green maize, and also all other plant nutrients except N. Application of 10 tons cattle kraal manure ha^{-1} amounts to 1 kg of cattle kraal manure per square metre. We recommend that you spread the cattle kraal manure evenly over the surface of the strip before ploughing, or after ploughing but before disking and ridging. After that you apply LAN as explained for chemical fertilisers in option 1 or option 2.

Using cattle kraal manure and poultry manure in combination

Poultry manure contains more N than cattle kraal manure and the N in poultry manure is also more available to plants than the N in cattle kraal manure. When using these two types of animal manure in combination, the use of LAN can be reduced. We have not

tried out this strategy but it is commonly used by farmers in the Transkei region. Our research has shown that a combination of 5 tons cattle kraal manure and 5 tons of poultry manure per ha is safe. As with cattle kraal manure, spread the two manures evenly over the surface of the strip before ploughing, or after ploughing but before disking and ridging. You will need to apply LAN at least once, using the same rates and procedures explained for chemical fertilisers (option 1 or option 2), when the maize is about 60 cm high.

It will have become clear to you that nitrogen is an important plant food for maize. A lack of nitrogen in maize presents itself through the colour of the leaves. Maize that is adequately supplied with N has dark green leaves (Plate 11).

PLATE 11: Leaves of maize plants that are adequately supplied with N (nitrogen) have a deep-green colour

Leaves of maize plants that are short of N are pale-green and the lower leaves of such plants first turn yellow, and then they become brown in colour and die off (Plate 12). Lack of N in your green maize stand must be avoided as it substantially reduces cob size. As soon as you observe pale-green leaves in plants that are 30 days old or older, apply nitrogen (LAN) before the next irrigation as described for option 1 or option 2 under the heading ‘Using chemical fertilisers’.

PLATE 12: Hungry maize typically has leaves that are pale-green and die off quickly from the bottom, is stunted (short) in appearance and produces very small cobs or no cob at all

2.5 Irrigating green maize

Our research at Dzindi has shown that when the soil profile is charged with water (field capacity) at planting, which can be achieved by applying at least three irrigations before planting, green maize can be grown successfully by applying irrigation water once per week. This suits farmers on canal schemes, because they typically only have access to water once per week. When it starts raining, usually from the last week of October onwards, irrigation might in some years no longer be necessary but you should monitor the rainfall on a daily basis using a rain gauge positioned near your field at a height of 1.2 m well away from obstacles, such as trees. Irrigation on the allocated day can be suspended for one week when the rain that fell following the previous irrigation event exceeded 40 mm. If the rainfall during the previous week was less than 40 mm, you should irrigate, even when the soil surface appears moist.

We also recommend that you try to irrigate twice per week when the tassel of the maize starts to appear and that you continue with two irrigations per week (equal to about 40 mm per week) for a period of four weeks, unless of course you receive 40 mm of rain or more during a particular week. The reason for increasing irrigation frequency from once to twice per week during this four-week period is that maize is most sensitive to water stress from tassel emergence to about two weeks after pollen-shed. After this four-week period of two irrigations per week, you can return to the normal schedule of one irrigation per week until your green maize is ready for harvest. When irrigating twice per week, you irrigate on your scheduled day and again three or four days later but since this second irrigation is not part of your schedule you would have to negotiate access to water with a neighbour whose day it is to irrigate, or else you would have to irrigate at night, when, on most canal schemes where the flow is continuous, access to water is not contested.

2.6 Protecting your green maize crop

Plants need light, water, nutrients (plant food) and suitable temperatures to grow but they also need protection. Rodents (mice) and birds (guinea fowls and crows) can do a lot of damage to your crop by digging up the seed just after it has been planted. At Dzindi, rodents were problematic when green maize was planted during winter (May to August). Rodent traps were used to control rodents and scare crows to keep birds away.

When the maize plants emerge, it is the turn of cutworms to damage your crop. Cutworms are light-grey to dark-grey larvae of moths, which are about 3 cm in length (Plate 13). They cut the maize seedling just above the surface of the soil and kill it.

PLATE 13: Cutworms, the larvae of different kinds of moths, reside in the soil during the day and come out at night 'cutting' maize seedlings (and the seedlings of other crops) at the base just above the soil surface, thereby killing the seedling (photo by gardening.sheknows.com)

Spreading cutworm bait along the planted rows is a control measure that we have found to be effective. Apply cutworm bait immediately after planting. Do not wait until the maize seedlings emerge.

Remember that cutworm bait is **poisonous**. Label the container clearly to indicate that it contains **poison**. Keep it away from the reach of children and wear gloves when handling the bait. Wash your hands thoroughly with soap immediately after you have stopped working with the bait.

When the maize crop is about one month old, or 30 cm high, and you are ready to apply your first application of LAN, you should also apply granular Dipterex in the whorl (the funnel created by the leaves) of the plants. This will protect them against top grub (Plate 14) and stalk borer (Plate 15).

PLATE 14: Top grub refers to damage (holes) made by larvae of moths to young maize leaves developing inside the whorl or funnel of maize plants and can be controlled effectively by applying granular Dipterex when the plants are about one month old

PLATE 15: Stalk borers, which are larvae of moths that eat into the stem and later on into the developing cobs can be controlled by applying granular Dipterex when the maize is about 30 days old

Dipterex granular looks just like salt and should be dispensed in the whorl of the maize plants using a cool drink bottle with a perforated cap, the same way as you sprinkle salt on food. A few granules per plant are enough. Applying too much burns the young leaves and will damage your plants.

Note that Dipterex granular is **poisonous**. Label the container clearly to indicate that it contains **poison**. Keep it away from the reach of children and wear gloves when handling the poison. Wash your hands thoroughly with soap immediately after you have stopped applying Dipterex.

2.7 Filling up the gaps in your green maize stand

Maize is most susceptible to damage during the first 30 days of growth, perhaps for a bit longer when planted in the middle of winter (June-July), when growth is slower due to low temperatures. Losing some of the plants in your stand during early growth is almost

unavoidable, even when you protect your maize carefully against the various pests described in these guidelines. Planting pumpkins is one way of filling the gaps in the maize stand (Plate 16).

PLATE 16: Planting pumpkins in your green maize stand is one way of filling up gaps due to missing plants and derive extra income from selling leaves, flowers and young fruit

Pumpkin leaves are a popular vegetable in Vhembe and good money can be made from selling the leaves, flowers and small fruits to fresh produce traders (Plate 17). As they grow, pumpkin plants fill up the gaps between the maize plants and cover the bare soil with their leaves. Our work at Dzindi shows that when planted at the same time as maize or later on, they do not affect cob size of maize and also do not increase water use. Leave at least 1.5 metre between adjacent pumpkin plants in any direction to avoid overcrowding.

PLATE 17: Leaves, flowers and young fruit of pumpkins are readily sold to fresh produce traders in Vhembe

2.8 Controlling weeds

Weeds are plants and when provided with light, water, and plant food (fertilisers), they grow well, just like maize. Weeds steal the light, water, food that was meant for maize. When you allow weeds to grow in a maize field, the maize plants will get less light, water and plant food than intended. As a result, it will remain stunted (short) and will not produce a large cob. For this reason, you should keep your maize stand free of weeds, at least until about two weeks after pollen-shed (Plate 18).

PLATE 18: The male flower (tassel) of a maize plant shedding pollen, a yellow powdery substance

In canal irrigation weeding is best done by hand hoeing between the rows and plants and by manually pulling out the weeds close to the maize plants to avoid damaging them with your hand hoe.

2.9 Harvesting

Green maize is ready for harvest at about 90 to 110 days after planting, depending on when it was planted and the temperature during the growing season (Plate 19). Green maize is typically harvested just after the late dough stage (about 46 days after pollen-shed) and before the hard dough stage (about 56 days after pollen shed). This gives farmers about a week after the kernels have reached the dough stage to sell their cobs as green maize. Contact should be made with potential customers (street traders) when the maize is approaching the dough stage (no more milky liquid appears when kernels are squeezed between thumb and finger nail but the kernel remains fairly soft and can

still be squashed). This will provide you with ample time to sell your crop before the cobs are too old.

PLATE 19: Contact street traders or other clients in time and inform them when your green maize will be harvest-ready to ensure that your crop is sold before the cobs are too old

2.10 Green maize enterprise budget

Table 2 shows the green maize enterprise budget for an area of 1000 m^2 planted to this crop. This area of 1000 m^2 is more or less the area covered by a typical irrigation strip on a canal scheme in Vhembe. Note that the listed costs of the various inputs (variable costs) in Table 2 refer to January 2013. As you know, prices change all the time, and usually they increase. Table 4 is there for you, the farmer, to adjust the prices listed in Table 2 to the current situation. Before you decide to plant green maize, you should first fill in Table 4 and develop your own green maize enterprise budget. If the margin above costs looks good (positive), then you are likely to make money from green maize production. Use Table 5 to assess risk.

In the enterprise budget presented in Table 2, we assumed that 90% of the cobs produced (1998 cobs) will be sold as green maize, and that the remaining 10% (224 cobs) will not generate income. We did not consider the option of planting pumpkins for leaf harvests to generate additional income. We assumed that there was no payment for water or for pumping. We also assumed that with the exception of ploughing, disking and ridging, all other production activities (planting, applying fertilisers and pesticides, irrigating and weeding, and removal of the stover – cutting the stalks and removing these from the land – after traders have harvested the crop) are done by you, the farmer. If you hire labour for any of these activities, the cost (what you pay to hire labour) must be added to the variable costs. As explained in these guidelines, traders, not farmers, harvest green maize.

The enterprise budget in Table 2 shows that in January 2013 the total variable costs of producing green maize on a 1000m^2 plot amounted to R830.00, whilst the gross income from selling 90% of the cobs was R3 998.00. The resulting margin above costs was R3 998.00 - R830.00 = R3 168.00. The margin above costs is what you the producer receives for taking the initiative to grow green maize and for doing the various production activities as mentioned in the previous paragraph.

TABLE 2: Green maize enterprise budget for a 1000 m^2 irrigation strip (January 2013, Dzindi Irrigation Scheme)

Budget component	**Unit**	**Cost per unit**	**Number of units**	**Value per strip of 1000 m^2**
Income				
Green maize sold	cob	R2.00	1 998	R3 998.00
Green maize not sold	cob	R0.00	224	R0.00
Gross income				**R3 998.00**
Variable costs				
Ploughing (hired service)	1000m^2	R70.00	1	R70.00
Disking (hired service)	1000m^2	R60.00	1	R60.00
Ridging (hired service)	1000m^2	R60.00	1	R60.00
Seed (SC701)	kg	R67.00	1	R67.00
Fertiliser 2:3:4 (30)	kg	R7.20	30	R216.00
Fertiliser LAN (28% N)	kg	R6.30	30	R189.00
Kombat cutworm bait	kg	R70.00	2	R140.00
Efekto stalkborer granules	kg	R35.00	0.4	R28.00
Total variable costs				**R830.00**
Margin above costs				**R3 168.00**

In Table 3 we provided a risk assessment tool that enables you to assess the effect of having a less than 90% proportion of the cobs sold as green maize. This could be the result of a lack of demand for green maize cobs, or because the cobs do not meet the

quality criteria of street traders. Table 3 shows that when only 10% of cobs are sold as green maize, the green maize enterprise would make a loss. However, remember that in all the calculations, the income that would be generated by harvesting the cobs for grain was ignored.

TABLE 3: Assessing risk in green maize production on a 1000 m^2 irrigation strip (January 2013, Dzindi Irrigation Scheme)

Proportion of cobs sold as green maize	**Income**	**Total variable costs**	**Margin above costs**
90% (1998 cobs at R2 per cob)	R3 998.00	R830.00	R3 168.00
80% (1778 cobs at R2 per cob)	R3 555.20	R830.00	R2 725.20
70% (1555 cobs at R2 per cob)	R3 110.00	R830.00	R2 280.00
60% (1333 cobs at R2 per cob)	R2 666.00	R830.00	R1 836.00
50% (1111 cobs at R2 per cob)	R2 222.00	R830.00	R1 392.00
40% (888 cobs at R2 per cob)	R1 776.00	R830.00	R946.00
30% (666 cobs at R2 per cob)	R1 333.20	R830.00	R503.20
20% (444 cobs at R2 per cob)	R888.00	R830.00	R58.00
10% (222 cobs at R2 per cob)	R444.00	R830.00	-R386.00

Good luck!

ADDITIONAL READING

CROSBY CT, DE LANGE M, STIMIE CM and VAN DER STOEP I (2000) A Review of Planning and Design Procedures Applicable to Small-Scale Farmer Irrigation Projects. WRC Report No. 578/2/00. Water Research Commission, Pretoria, South Africa. 240 pp.

Comment: This research report provides information on short-furrow irrigation. It can be downloaded from the website of the Water Research commission free of charge. URL: http://www.wrc.org.za, select knowledge hub, select research reports, enter 'Crosby' in the search prompt and the report will appear as one of the publications.

MARAIS JN and ARDRI (Agricultural and Rural Development Research Institute) (1997) Garden mealies for six months: The National Department of Agriculture, Pretoria, 16 pp.

Comment: This booklet contains useful information on green maize production on a small-scale. It was prepared specifically for smallholders in the Eastern Cape. It is obtainable free of charge from the Resource Centre, Directorate Communication, Private Bag X144, Pretoria 001.

VAN AVERBEKE W and YOGANATHAN S (1997) Using kraal manure as a fertiliser. The National Department of Agriculture, Pretoria, 19 pp.

Comment: This booklet contains useful information on the use of kraal manure as a fertiliser in crop production. It is obtainable free of charge from the Resource Centre, Directorate Communication, Private Bag X144, Pretoria 001.

Comments, suggestions and questions on the content of these guidelines are most welcome.

Please send your contributions to:
Wim Van Averbeke
Department of Crop Sciences
Tshwane University of Technology
P Bag X680
Pretoria 001 or
vanaverbekew@tut.ac.za
or
vanaverbekew@gmail.com