Maize Production Guide

Zambia Agriculture Research Institute
ZARI
Researching Soils, Crops and Water In Zambia

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AGRICULTURAL PRODUCTIVITY PROGRAMME FOR SOUTHERN AFRICA
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Agricultural Productivity Program for Southern Africa (APPSA)

Table of Contents

Foreword

Zambia has the potential to produce sufficient food for its citizens and for export.

In order to ensure that good agricultural practices are employed by farmers, crop specific production information should be made available to them.

Due to technological advances and the changing environmental and socio-economic conditions it became necessary to revise the first edition of the Maize Production Guide, which was published in 2002. This revised edition is meant to provide farmers and other stakeholders crop specific information in order to promote good agricultural practices and enhance productivity and production.

The information contained in this booklet has been generated over a number of years of research and is appropriate for all categories of farmers. The information is meant for extension officers, agricultural training institutions and other development partners.

It is my sincere hope that this information will go along way in stimulating Maize production in Zambia.

The Zambia Agriculture Research Institute (ZARI) is committed to alleviating poverty and enhancing food security by contributing to increased and sustainable food production.

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Ministry of Agriculture,

2018

Acknowledgements

The Editorial Committee wishes to express its gratitude to the Maize Research Team of Zambia Agriculture Research Institute and CIMMYT for providing the technical information and invaluable advice.

he Zambia Agriculture Research Institute wishes to recognize the support provided by the Feed the Future (FtF) Program of the United States Agency for International Development (USAID) through its bilateral Mission Office of Zambia.

We also wish to recognize financial support provided by the World Bank through the Agricultural Productivity Programme for Southern Africa- Zambia Project (APPSA-Zambia) to facilitate the publication of this production guide.

1.0 Introduction

Maize (*Zea mays L*) is a member of the family Gramineae, which originates in the Andean regions of Central America. In Zambia maize is an important crop as it is both a staple and a cash crop grown by all categories of farmers throughout the country. The per capita consumption of maize averages between 140-160 kg per year whilst the daily dietary intake of majority of Zambians consists of more than 70% carbohydrate. Maize is also used for manufacturing of feeds (poultry and dairy feeds) and beverages. White maize is the type that is predominantly grown and used in Zambia. However, yellow and orange maize (pro-vitamin A) types are also available.

Maize varieties suited for the different regions of Zambia have been developed. To obtain optimum maize yield levels, it is necessary for farmers to plant appropriate varieties depending on the region in which they are situated.

2.0 Climatic and Soil Requirements

2.1 Climate

Maize does well under frost free conditions and when mean daily temperatures are above 15°C. For germination, the lowest mean daily temperature is about 10°C with 18 to 20°C being optimum. Hot sunny weather with short rainy intervals are favourable to maize growth.

2.2 Soil Types

Maize can be grown successfully on a wide range of soils. The heavy textured soils which are inherently high in fertility are considered to be the most suitable. These soils have a higher water holding capacity than the lighter soils and can sustain growth for longer periods than sandy soils during drought periods or at the end of the season. It is essential that the soils are free draining as maize will not thrive in water logged conditions.

Shallow soils should be avoided as maize roots can penetrate to over 1 meter in depth. In addition, soils with a low pH, less than 4.5

are not suitable as maize is sensitive to acidity at this level and below.

VARIETY	Days to Maturity	Potential Yield (t/ha)	RECOMMENDED REGION FOR PRODUCTION	CHARACTERISTICS
MMV 409 (OPV)	120-130		I,II	Extra early Open pollinated variety (OPV), drought and low soil fertility tolerant. Good resistance to GLS, Northern leaf corn blight and ear rots. Suitable for drought prone areas
MMV 607 (OPV)	130-140		II,III	Open-pollinated variety (OPV), white semi flint, resistance to GLS, Blight, MSV, tolerant to drought and low nitrogen. Suitable for drought prone areas
GV 662A	130-140		II,III	Three way cross hybrid, high in pro - vitamin A (6.9±1.02µg/g). Orange semi flint grain colour. Good tolerance to GLS and Northern corn leaf blight
GV 664A	130-140		II,III	Three way cross hybrid, high in pro - vitamin A (7.16±1.08 µg/g). Orange semi dent grain colour. Good tolerance to GLS and Northern corn leaf blight.
GV 665A	130-140		II,III	Three way cross hybrid, high in pro - vitamin A (7.81±1.43 µg/g). Orange flint grain colour. Good tolerance to GLS and Northern corn leaf blight.
GV 628	130-140		II,III	Three way cross hybrid. Tolerant to drought and low soil fertility. White semi flint grain. Good resistance to GLS, Northern corn leaf blight and ear rots. Suitable for drought prone areas
GV 635	130-140		II,III	Three way cross hybrid. Tolerant to drought and low soil fertility. White semi flint grain. Good resistance to GLS, Northern corn leaf blight and ear rots. Suitable for drought prone areas
GV 665	130-140		II,III	Three way cross hybrid. Tolerant to drought and low soil fertility. White semi flint grain. Good resistance to GLS, Northern corn leaf blight and ear rots. Suitable for drought prone areas
GV 613	130-140		II,III	Three way cross hybrid, with good cob - size. The grain is semi -flint. Tolerant to drought and low nitrogen. Resistance to GLS, MSV, Blight and turcicum. Suitable for drought prone areas

GV 637	130-140		II,III	Three way cross hybrid. Tolerant to drought and low soil fertility. White semi flint grain. Resistance to GLS, Northern corn leaf blight and ear rots. Suitable for drought prone areas
GV 638	130-140		II,III	Three way cross hybrid. Tolerant to drought and low soil fertility. White semi flint grain. Good resistance to GLS, Northern corn leaf blight and ear rots. Suitable
GV 671A	130-135		II,III	Three way cross, Orange, resistant to turcicum, MSV and ear rots. The variety is moderately resistant to GLS.
GV 672A	130-135		II,III	Three way cross, Orange, resistant to turcicum, MSV and ear rots. The variety is moderately resistant to GLS.
GV 673A	130-135		II,III	Three way cross, Orange, resistant to turcicum, MSV and ear rots. The variety is moderately resistant to GLS.
MM 498	118-130		I,II	Single cross, white, tolerant to ear rots.
GV 557	115-125		I,II	Three way cross hybrid , white, drought and low nitrogen tolerant resistant to turcicum, GLS, MSV and ear rots.
GV 659	135-145			Single cross, white dent, moderate tolerant to GLS, tolerant to drought and low nitrogen. Suitable for drought prone areas
GV 553	115-125		I,II	Three way cross hybrid, white semi flint grain, drought and low nitrogen tolerant, resistant to turcicum, GLS, MSV and ear rots. Suitable for drought prone areas
GV 552	115-125		I,II	Three way cross hybrid, white semi flint grain, drought and low nitrogen tolerant, resistant to turcicum, GLS, MSV and ear rots. Suitable for drought prone areas
GV 682P	130-140		II,III	Three way cross, white, contain lysine and tryptophan. Better performance under optimal, low N, random stress and at high population density.
GV 687P	130-140		II,III	Three way cross, white, contain lysine and tryptophan. Better performance under optimal, low N, random stress and at high population density.

3.0 Recommended Varieties

Some of the varieties that are suitable for different regions with their characteristics are shown in the table below. Farmers in drought prone areas i.e. region I and parts of region II are advised to plant maize varieties that are drought tolerant.

4.0 Recommended Management Practices

4.1 Land Preparation

In conventional cultivation system, winter or early ploughing is beneficial as this helps in killing weeds, conserving moisture, reducing costs and allowing for maximum decomposition of crop residues to take place before planting.

The aim of land preparation is to loosen the soil and control weeds, pests and diseases. A good tilth is essential for the crop but it should not be too fine. One good discing or harrowing is usually all that is required, although if clods persist a second discing/harrowing may be necessary. These cultivations should give a satisfactory seed bed and at the same time ensure that the land is free from weeds at planting time.

Where Conservation Agriculture (CA) is being practiced, which among other things emphasis minimum tillage, ploughing and discing may not be required. Instead ripping and pot holing to make basins is done to prepare land for planting.

4.2 Planting

Recommended planting dates for different varieties and agro-ecological regions should be followed.

In general, it is advisable that planting is done as early as possible with the onset of rains. Currently, the recommended planting period is early November to mid-December. The later the maize is planted after the onset of rains, the lower the yield will be. Dry planting in October can be beneficial if the first effective early rains are not followed by dry spells.

Nevertheless, it is a very useful practice for labour management purposes.

Spacing

In Zambia, the recommended inter-row spacing is 75-90 cm with intra-row spacing of 20-30 cm depending on varieties.

The optimum plant population will depend on variety type and level of management. In general, the higher the inherent potential and

management levels, the higher the optimum plant population. With late maturing hybrids, under fairly favourable growing conditions, there is a marked increase in yield, at populations of 30 000-40 000 plants/ha. When grown under less favourable conditions, the optimum population can be reduced to as low as 30 000 plants/ha. For early maturing varieties, optimum plant population under favourable growing conditions yield increases significantly with population of up to 50 000 plants/ha. When grown under less favourable conditions, the plant population can be reduced to about 30 000-40 000 plants/ha. In general however, a plant population of 44 000 plants/ha is recommended for the present varieties. To achieve this, a seed rate of 20 kg/ha is used.

In Zambia it is recommended that seed should be planted 5 cm deep in moist heavy soil and 8 cm in light soils.

This can be modified depending on soil status i.e. wet or dry. For dry planting, plant up to a depth of 8-10 cm and on soils with a high crusting risk, seed should be planted slightly shallower than 5 cm. Under CA, planting can be done by use of a dibblestick or in a ripline, which are described in the following.

Dibble stick planting system

A dibble stick is a sharp pointed stick which is used for opening holes for seed and basal fertilizer placement. The stick can be 1.2-1.5 m long and a farmer can easily plant in a mulched field with limited challenges. The farmer makes holes with the stick at recommended seeding depth and plant spacing.

Low fertility status:	Medium fertility status:	High fertility status:
160-180 kg-N ha^{-1}, 70-100 kg-P O ha^{-1} and 30-40 kg-K O ha^{-1}	120-140 kg-N ha^{-1}, 40-60 kg-P O ha^{-1} and 10-20 kg-K O $ha^{-1.}$	80-100 kg-N ha^{-1} and 20-30 kg-P O $ha^{-1.}$

Dibblestick planting method has the following advantages:

a) Low initial cost of the planting equipment
b) Low labour requirements compared with the traditional ridge and furrow or basin planting system
c) High precision – seed and fertilizer quantities and placement done with precision
d) A wide range of crops grown by smallholder farmers can be seeded using this seeding system
e) Increase crop yields with time compared with the conventional farming system

SOILTYPE	CRITICAL pH	APPLICATIONRATE (kg/ha)
Sand	4.4	500- 1,000
Sandy loam	4.6	1,000- 1,500
Sandy clay	4.8	1,500- 2,000

Ripline planting

Ripline seeding uses a ripper tine attached to a beam of a conventional moldboard plough. Some manufacturers in southern Africa also produce specific beams designed for the ripper tines. Ripper tines available in southern Africa include those with and without wings. All types can be pulled by two oxen and/or donkeys.

Ripeline planting method has the following advantages:

a) A farmer can use the beam of a conventional plough to attach a ripper tine before use - this keeps prices low
b) Land preparation is fast because ripline furrows can easily be opened
c) Require less draught power compared with the conventional ploughing system
d) High precision because seed and fertilizer/manure are manually placed at each planting station
e) Ripline furrows harvest rainwater and also reduce surface

runoff in the cropping fields

f) Increase crop yields with time compared with the conventional farming system

4.3 Weed Control

Cultural practices such as hand hoeing can be used to keep fields free from weeds. Weeds can also be controlled by use of herbicides. Some of the herbicides recommended for weed control in maize are given in the table below.

Glyphosate - A non-selective and systemic herbicide which kills actively growing weeds. Apply glyphosate 3-4 days before or after sowing but before the crop emerges. The effect of glyphosate on weed plants begins to be seen 7-14 days after application

Basagran - A selective and contact herbicide applied to actively growing weed plants at 2-4 leaf stage. Apply to actively growing weed plants at 2-4 leaf stage. Effect of Basagran on weed plants is seen 2 days after application and a second application can be done 10-14 days after the first spray if weed control has not been achieved with the first application.

Bullet - A selective and contact herbicide which can be applied to the soil or on weed foliage. Apply at planting or during crop growing period whenever necessary. Effect of Bullet on weed plants can be seen 4-5 days after application.

Accent - A elective and systemic herbicide applied to actively growing weed plants and can be applied from 3-5 leaf to flowering growth stages of the maize crop. apply to actively growing weed plants and can be applied from 3-5 leaf to flowering growth stages of the maize crop. Accent should not be sprayed over maize funnels after 3-5 leaf stage. Effect on weed plants is seen 12-14 days after application.

Agil - A systemic herbicide and should be applied to actively growing grasses at 3-5 leaf stage

Paraquat - A selective and contact herbicide, which should be applied to young actively growing weeds. Apply to young actively growing weeds. Paraquat acts very fast and its effect on weed plant foliage can be seen after a few minutes of application. This can be applied before planting or a few days after planting, but before seedlings emerge.

4.4 Fertiliser Use

The application of fertilisers is necessary for attaining good yields in maize. The major nutrients are Nitrogen, Phosphorus and Potassium because they are most likely to limit yields on most soils. In some soils, micronutrients such as zinc and sulphur are required. The recommended fertilizer rates for different soil fertility status are given in the table below.

Low fertility status:	Medium fertility status:	High fertility status:
160-180 kg-N ha-1, 70-100 kg-P O ha-1 and 30-40 kg-K O ha-1	120-140 kg -N ha -1, 40-60 kg -P O ha -1 and 10-20 kg-K O ha-1.	80-100 kg-N ha-1and 20-30 kg-P O ha-1.

For specific site recommendation soils testing is recommended.

Basal fertilizer should be applied at planting at a rate of 200 – 400Kg/ha by banding below the seed. The actual rate applied is dependent on the target management level and resource endowment of a farmer.

Top dress fertilizer should be applied 4-6 weeks after germination at a rate of 200-400Kg/ha by banding on the surface. In high rainfall areas it is advisable to cover the feriliser with soil.

Lime application may be necessary in soils which are acidic. The actual recommended requirements for different soils types and pH

levels are given in the table below. However for site specific lime requirements will require soil testing.

SOILTYPE	CRITICAL pH	APPLICATIONRATE (kg/ha)
Sand	4.4	500- 1,000
Sandy loam	4.6	1,000- 1,500
Sandy clay	4.8	1,500- 2,000

4.5 Crop Rotation

Maize should not be cultivated in the same field continuously following another cereal. It should be rotated with a legume so that it benefits from residual nitrogen. The common legumes currently grown in rotation with maize in southern Africa are cowpea, groundnuts, common beans, and pigeon pea. Non-leguminous rotations include cash crops such as cotton and sunflower.

Maize can be inter-cropped with cowpea, groundnuts, common beans, velvet beans and pigeon pea. Inter-cropping can be practiced at the same time or relay cropped (e.g. one crop is seeded into a standing crop and harvested long after the first crop has matured).

The following spatial arrangement of component crops can be used in an inter-cropping system:

- Alternating rows of component crops i.e. one row cereal followed by a row of legume
- Two rows of legume between single rows of cereal
- Alternate positions of cereal and legume in the same row

Maize and legume crops in an inter-cropping system can be planted on the same day or on different dates depending on the growth habit/pattern of the legume.

5.0 Crop Protection

The maize crop is affected by a number of pests and diseases which result in poor crop performance and loss in yield. It is therefore important that measures are taken to control these pests and diseases.

5.1 Major Diseases and Control Measures

The major diseases of maize include Leaf Blight; Maize Streak Virus (MSV); Rusts; Cob rots and Grey Leaf Spot (GLS)

5.1.1 Leaf Blight *(Exserohilum turcicum)*

This is caused by a fungus *(Exserohilum turcicum).* When the crop is attacked, long, elliptical, greyish lesions, first form on the lower leaves, later spreading up the plant. The disease becomes most severe after long wet spells.

Control Measures

The disease can be controlled by ploughing the infected plant material under, avoid planting maize continuously in the same field and use of tolerant varieties. Use of appropriate fungicide is recommended.

5.1.2 Maize Streak Virus (MSV)

This disease is caused by a virus transmitted by leaf-hopper insects (Cicadulina mbila). This is a major disease in region III. Symptoms include narrow chlorotic, yellow streaks along the veins of the leaves. In severe cases the whole plant is chlorotic and stunted and does not bear cobs.

Maize streak virus on leaves

Control Measures

Control measures include early planting as fewer plants will be affected compared to the late planted crop and use of resistant varieties. Spraying systemic insecticides for the control of the leaf

hopper insects is recommended.

5.1.3 Rusts *(Puccinia sorghi and Puccinia polysora)*

The forms of rusts found in Zambia at present and the damage they cause is not of economic concern. The most common form of Rust *(Puccinia sorghi)* (one with rusty coloured spots) does little damage. But the rarer form (one with yellowish-red spots); *Puccinia polysora;* can do more damage.

Common rust appears mostly when plants approach tasseling. It is recognized by small, elongate, powdery pustules over both surfaces of the leaves. Pustules are dark brown in early stages of infection; later, the epidermis is ruptured and the lesions turn black as the plant matures.

Polysora rust appears as pustules which are smaller, lighter in colour (light orange) and more circular than those produced by common rust. They are also present on both leaf surfaces, but the epidermis remains intact longer than it does in common rust infected leaves. Pustules turn dark brown as plants approach maturity.

Control Measures

Control measures include early planting and use of resistant varieties. If infections become severe, use of appropriate chemical control may be justified. Distroy infected crop residues and weed hosts.

5.1.4 Cob Rots *(Diplodia spp. and Fusarium spp.)*

These are caused by a number of fungi such as Diplodia spp. and Fusarium spp. The fungi enters the cobs through exposed tips and causes the rotting of the cobs.

Control Measures

Control measures include burning of the affected plant material, crop rotation and use of resistant varieties. Treat seed with appropriate fungicide dressing.

5.1.5 Grey Leaf Spot *(Cercospora zeae maydis)*

This is caused by a fungus called *Cercospora zeae maydis*. When the crop is infected, within two weeks the lesions gradually elongate, appearing as streaks at first then developing their dark greyish brown rectangular shape. If infection occurs in the early crop stages, yield losses can be quite significant.

Gray leaf spot (Cercospora zeae maydis)on on leaves

Control Measures

To control GLS, grow resistant maize varieties, practicing crop rotations, field sanitation by burying or burning crop residue, using seed which does not contain debris. There are also a number of chemicals that can control GLS such as Zoom, Benlate (benomyl), Aerial, Punch and Folicure. Spraying has to be started when the disease has covered 2- 3% of the leaf surface or when the lesions are restricted to the basal five leaves of the maize plant.

5.2 Major Pests and Control Measures

The most important insect pests of maize in Zambia are Maize Root Worm, Fat John; Cut worms; Stalk borers; Larger Grain Borer (LGB); Maize weevils and Termites.

5.2.1 Root worm

The larvae of this insect bores into the underground stem of young seedlings causing the whole plant to become deformed and eventually die. .The first obvious signs of root worm damage is the wilting of the central stem when the seedling is at two or more leaf stage. The central shoot shrivels and dies then the leaves turn bluish green. This pest is a serious one in southern province, but precautionary measures against this pest should be taken in other parts of the country as well.

Control Measures

Control measures can only be used against this pest when necessary. However, use of appropriate chemical insecticides and

crop rotation is recommended.

5.2.2 Fat John
The grub of this weevil causes similar damage to that of the rootworm and therefore, similar control measures can be applied.

5.2.3 Cut Worm
These are caterpillars of greyish or brownish color. They eat the seedlings just above ground level.

5.2.4 Stalk Borer
Three species of stalk borers occur: Busseola fusca, Chilo partellus and Sesamia calamitis. Their proportions in the complex vary from season to season and place to place. Grain yield losses due to attack by stalk borers range from 15-30%.

The larvae feed on the rolled up leaves making their way down the funnel of the plant, leaving behind feeding marks on the surface of the leaves. Small dark caterpillar can be found in the heart of the plant. These can damage maize cobs too.

Control Measures
Control measures include the use of cultural practices such as winter plowing of the maize residues to destroy the over-wintering larvae, early planting within the first week of December and use of tolerant varieties. Chemicals that are used as control measures applied in the tunnel or sprayed include Fastac, Cabaryl while Furadan is applied at planting. Botanical extracts such as Tephrosia vogelii and Neem, may be applied to control stalkborers.

5.2.5 Larger Grain Borer
This is a serious pest of stored maize and dried cassava. It can cause contamination and losses of up to 30-40% weight loss in unshelled maize.

Control Measures
Immersing used jute sacks in boiling water to kill insects, exercising good storage hygiene and storing clean grain.

5.2.6 Maize Weevils
This is a serious pest of stored maize. The damage include grain boring, contamination, reduced grain weight and in the case of seed, reduced germination.

Control Measures
Measures used to control LGB; can be used to control maize weevils

5.2.7 Termites
These are a problem in some parts of regions I and II attacking the crop at harvest. Attacks are also observed when dry spells occur during the growing season.
Control Measures
To control termites apply 2% Dieldrin. Dust using an old stocking or muslin bag along the rows and around plants. In addition, this can also be applied as liquid spray along rows and around plants.

6.0 Harvesting
Harvesting of maize takes place when the grain is mature. Maize is mature when the grain has about 30-32% moisture content and a black layer has appeared on the grain.

Maize stooking, has the advantage of clearing the land quickly for early plowing, but the maize dries more slowly which gives insects a chance to damage the harvest. Therefore, stooking is not recommended.

Hand picking is the usual method of harvesting followed by spreading out the cobs on the floor for quick drying.
Machine harvesting, should take place much later than hand picking since the grain has to be drier when machines are used.

7.0 Post-Harvest Handling and Processing
The grain must be dried quickly after harvesting. After drying, the maize is shelled and the grain bagged and stacked under a shelter. Grain must be well dried before being placed in bulk storage. Storage bins must be situated in a shade because fluctuations in the daily temperatures can cause sweating and condensation of

moisture leading to development of moulds.
The most satisfactory method of storage is to shell the grain, mix it with Actellic Super Dust according to manufacturer's instructions and store in a cool dry place.

Small scale improved storage technologies appropriate at smalll-scale level are available.

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