Production Guide

Sorghum & Pearl Millet in Zambia

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Foreword

Sorghum and pearl millet are traditional and staple crops that are widely used in Zambia and other countries in the region. However, because of the evolution and influence of commercial farming, increased urbanization and subsequent need and ease of industrial maize processing, and government policies for in-put supply, crop marketing and storage etc., maize has replaced these cereal crops, even in areas where it is less suited.

The problem of over dependence on maize has, however, been lately recognised and efforts are now under way to promote the above mentioned traditional crops. The government's policy of crop diversification, coupled with the frequency of drought years has brought to the fore the importance of these crops.

In the last few years countries in Southern Africa under the auspices of SADC and in particular SACCAR (now SADC FANR) have established regional research centres with mandates to work on these crops. As a result of the collaborative work among these countries and international research centres (CGIAR) a number of varieties have been developed, evaluated and released.

This publication is an attempt to improve on the earlier version and include new information (management practices and varieties) on these crops. It is hoped that this publication will be found useful by field staff and farmers alike in Zambia and the region as well.

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Introduction

Sorghum and pearl millet are some of the drought tolerant crops that are extensively grown in Zambia and other countries of southern Africa. The crops thrive well in areas of moisture deficit, high ambient and soil temperatures and where other crops would normally fail. Therefore the importance of these crops in providing livelihood to inhabitants of these areas is critical.

The country is divided into three agro-ecological regions (Figure 1). Region I comprises of the valleys and southern and western parts of the country and is characterised by low and erratic rainfall (600 - 800 mm), often coupled with high heat stress. This region covers the valleys which lie between 300 - 900 metres above sea level and parts of western and southern provinces with elevations between 900 - 1200 metres. Mean temperatures can be as high as 38 C in August - October.

Region II covers the central belt of the country and is further sub-divided on the basis of soil types into sub-regions IIA and IIB. The total rainfall is in a range of 800 - 1000 mm and the length of growing season from 100 - 140 days. The region includes agriculturally good potential areas of the country. Mean daily temperatures during the growing season range from 23 - 25 C. Maximum temperatures may reach 32 C. Elevation is between 900 - 1300 metres above sea level.

Region III is characterized by high rainfall, exceeding 1,000 mm. Although rain fall is more than adequate, the production of crops may be limited by few sunshine hours (4 to 5). The soils of the region in general are highly acidic, low in CEC and have high concentration of aluminium and manganese. Elevation is between 1100 - 1700 metres above sea level. Mean daily temperature range is 16 - 20 C.

Sorghum cultivation is widely distributed through out the country while pearl millet is mainly confined to the western and southern part of the country.

A lot of research has continued in these crops and a number of technologies have been released to farmers and end-users. However, it is the field officers that relay these technologies to farmers and it is therefore critical that they keep abreast with this new information.

This publication is an update to the previous one published in 1989 and is intended to equip extension staff and whoever is interested in growing these crops with new information to help farmers and end-users in their decision making. This publication gives basic information on the successful production of these crops. The information contained in this book could also be useful to farmers themselves and end-users.

In conclusion, it has to be stressed that the purpose of this publication is to assist field staff, farmers and end-users to keep up with the latest research results to enable them make informed decisions.

Chapter One
Sorghum

1.1 Introduction

Sorghum (*Sorghum bicolor*) is one of the most important traditional cereal crops of the hotter and drier regions of the tropics and subtropics (Rao et al. 1989). It belongs to the grass family, graminae. In areas with uncertain and erratic rainfall sorghum is a preferred crop. In the developing world the crop is largely grown by resource poor small scale farmers for their subsistence. In those countries with a policy of crop diversification in place sorghum can play an important role in achieving food security at the household level.

Sorghum has many attributes that help it withstand drought conditions. These are:

- a more extensive root system than other cereal crops
- less leaf surface area than maize and the leaves are covered with wax which helps reduce water loss through evapotransipiration
- the ability to stay dormant when conditions are not favourable

Zambia requires two different types of sorghum. One type with tropical adaptation for high rainfall areas (1000 - 1400mm) of the north (Chisi et al. 1997). These sorghums should be semi- to photo-period sensitive and must possess high resistance to soil acidity and anthracnose. The second group for southern areas should be sub-tropical in adaptation. These varieties must be photo-period insensitive with good levels of resistance to moisture-stress, heat and a number of diseases i.e. leaf blight, sooty stripe, downy mildew, and MDMV.

1.2 Varieties

Both open pollinated varieties and commercial hybrids are now available in Zambia. Hybrids give higher and more stable yields across seasons, locations and management levels, as they are capable of facing adverse growing conditions better than open pollinated varieties. Open varieties are specific in their performance.

Traditional varieties of sorghum require a long growing season, have low yield potential, and are tall and non-responsive to improved management. Improved sorghums, however, are high yielding, input responsive, and far more resistant to drought.

Several varieties that are high yielding (4.5 - 8 tons/ha) and ideal for various end-uses (forage, food and brewing types) have been released to the differ-

ent categories of farmers in Zambia (Table 1). The maturity of these varieties ranges from 110 - 130 days.

Kuyuma

This is an early, short, white grain variety with tan plants and with excellent milling properties. It is widely adapted to low rainfall areas with good resistance to most diseases in Zambia, except for anthracnose. The variety has been evaluated in Tanzania, Mozambique, Zimbabwe, and Botswana with successful results.

Sima

A medium-tall, medium-late, tan plant, white grain variety with juicy and sweet stalks for dual purposes - grain and forage; it is well adapted to all three agro-climatic regions of Zambia and moderately resistant to diseases. This variety also does well in the neighbouring countries.

ZSV 12

A semi-photoperiod sensitive, pigmented white grain variety with good resistance to soil acidity and anthracnose, well adapted to high rainfall areas.

ZSV 15

A widely adapted, white-grained variety, excellent grain quality and good levels of resistance to all diseases - an improvement over Kuyuma variety for the drier areas.

WP–13

A photo-period sensitive, high yield potential pigmented white and large-grain land race variety with good resistance to anthracnose, soil acidity and adaptation to high rainfall areas. Depending on the type of management, grain yields range between 3 – 5 tons per hectare.

MMSH–375

Widely adapted, high yield potential, brown grain hybrid with moderate levels of tannin and good resistance to most diseases common in Zambia except for downy mildew; recommended for the entire country.

MMSH–413

A widely adapted high yield potential, brown grain hybrid with higher tannin content and excellent malting properties; resistant to most diseases. This hybrid is recommended for the entire country and some neighbouring countries as well.

MMSH-1324

A tan plant, white grain, early maturing, medium-height hybrid with good grain quality and high grain yield; widely adapted to dry areas, resistant to most diseases except for anthracnose.

MMSH-1257

A widely adapted high yield potential tan plant, white grain, medium-tall, medium-maturity hybrid with good levels of resistance to most diseases. The variety is recommended for production throughout the country.

1.3 Soils – Water and Soil Requirements

Sorghum does well in semi-arid tropics. It tolerates harsh weather conditions better than maize. It grows well at temperatures above 100 C. Some sorghum varieties are sensitive to day length especially the local types. In terms of adaptation, sorghum appears to be relatively more tolerant to soil acidity than maize but as a general principle, and bearing in mind other crops in the rotation, the pH should not be allowed to fall below 4.5 on sandy soils and 4.7 on clay soils. Sorghum is adapted to a wide range of soil types. It can be grown in heavy clay soils to light sandy soils. However, sandy loam soils with good drainage and organic matter are the best. In general the crop does not do well on acidic soils with aluminium toxicity. It is advisable to avoid soils with a pH below 4.5. The crop also can withstand some water logging giving desirable results.

Moisture conservation is critical in areas where sorghum is grown. To prevent soil evaporation, the soil surface must be tilled with a harrow to form a fine surface. Weeds use a large quantity of water and should be removed. In areas with sandy soils it is advisable to use a ripper instead of a plough. Minimum tillage practices should be employed to conserve water and the soil structure.

1.4 Management Practices

Experiments addressing crop management practices such as planting dates, optimum plant population density, planting methods have been conducted and

based on these results recommendations have been developed and are described below.

1.4.1 Seedbed Preparation

Sorghum needs a fine seedbed for planting as the seeds are small. A fine seed bed is critical where the seed has to be broadcast. However, plant seeds 3 - 5 cm deep. Deeper plantings may lead to poor germination. Weeds should be removed so that seeds are planted in a clean field.

1.4.2 Planting

Depending on the rainfall pattern, local varieties should be planted earlier than the improved varieties. For improved varieties, the first to third week of December in low rainfall areas is best for higher yields but planting can be done up to mid-January. In high rainfall areas planting should be done during the second week of December to the end of the month. When broadcasting, the seed should be spread evenly and the seed covered to a depth of 3 – 5 cm. The practice of broadcasting makes operations such as weeding and harvesting difficult. Spacing of 60 – 90 cm between rows and 15 – 30 cm in the row is recommended. In general planting should be done when there is adequate moisture in the soil. Inadequate soil moisture leads to poor germination.

Seed Rate

When planting is done with precision planters a low seed rate is recommended (7.0 kg ha^{-1}). When planted by hand-hoe, germination is seldom complete due to the uneven planting depth. Therefore, a higher seed rate (10 kg ha^{-1}) is recommended. The aim is to achieve a plant population of 120,000 to 180,000 plants/ha. For forage sorghums the seed rate is higher (15 - 20 kg ha^{-1}).

Planting Method

Planting can be done either in rows or in stations (in case of hand-hoe farmers). A row spacing of 75 cm is ideal. However, any row spacing from 60 cm to 90 cm can be used to suit machinery requirements. In the case of hand-hoe farmers, a spacing of 75 x 50 cm with 8 - 10 seeds per station is recommended. 3 - 4 plants per station should be retained after thinning. In very dry areas, 2 - 3 plants per station should be retained. Some farmers still prefer to broadcast the seed and this requires a lot of practice to use the right amount of seed per hectare.

Thinning

High plant population can lead to poor crop growth, especially under drought conditions. It is, therefore, advisable to thin out extra plants 3 weeks after planting to maintain a plant population in the range of 120,000 – 180,000 plants per hectare. Thinned plants can be transplanted on wet days to fill gaps. However, transplanted plants will not be as productive as the directly seeded plants.

1.4.3 Fertiliser Recommendations

Sorghum needs fertile and well drained soils. In general, resource poor farmers hardly use commercial fertilisers and practice the system of shifting cultivation. Utilising a cereal – legume rotation can be beneficial to such farmers. Sorghum – sun hemp rotation has been found to work well with farmers. In order to get maximum benefits from the improved types some fertilisers are necessary. For a good crop 200 kg ha^{-1} of 'D' compound as basal and 100 kg ha^{-1} of urea as top dressing is recommended. Small-scale farmers are advised to use one bag of 'D' compound as basal per lima and 25 kg of urea per lima as top dressing.

Green Manure

Green manuring is the process of growing of a crop with the aim of later ploughing it into the soil to improve the fertility of that soil. Leguminous species are usually chosen on account of their nitrogen - fixing capability. They supply both organic matter and fix nitrogen. A number of leguminous species can be used as green manure. In sorghum, sun hemp has been used with good results.

Seed

It is a common practice with small-scale farmers to retain seed of some of the open pollinated varieties that are grown. If seed will be retained then it is advisable to rogue out obvious off-types. The off-types include volunteers, outcrosses, wild sorghums etc. Off-types should be removed before they flower and cut from the ground level to prevent re-growth.

1.4.4 Weed Control

It is advisable to keep the field free of weeds in the early stages of growth. The first weeding should be done 2 - 3 weeks after planting. Should a second weeding be necessary then it should be done 5 - 7 weeks after the first one. Hand-hoe farmers are advised to plant sorghum after the first flush of weeds

following good rain. Planting after the first rains reduces weed population substantially. Keeping fields free from weeds in early growth stages is necessary for a good crop yield. Sorghum plants are more sensitive to herbicides than, for example, maize. “Atrazine” in low doses is effective during the early growth period. Commercial farmers could apply “Atrazine” at the rate of 3 litres per hectare as a pre-emergence application. Finally, the crop can be cultivated at the knee-high stage to control late weeds.

Witchweed - Striga or witchweed can be a serious parasitic weed of sorghum. It is a parasitic weed and its roots penetrate the roots of sorghum. The weed feeds on nutrients of its host and growth is therefore affected. Farmers should be advised to rotate their sorghum fields with other non-host crops such as legumes. Where it is observed, farmers should be advised not to allow the plant to flower as this reduces its spread.

1.4.5 Birds

Birds are undoubtedly the most serious pest of sorghum and yield losses due to bird damage can be high. If possible avoid small hectarages and swampy areas that are breeding places for the birds. Bird scaring measures from the soft dough stage onwards are considered essential. The brown seeded varieties should be grown in areas where birds are a serious problem.

1.4.6 Diseases and Pest Control

Diseases

Although many diseases are known to attack sorghum, very few of them cause economic losses. Here below are the common ones found in Zambia.

Smuts

Smuts cause various symptoms affecting the inflorescence and occasionally the foliage. Sori replace part or all of the panicle or form on rachis branches of the panicle. In dry environments, the smuts are of much concern especially if the seed was not treated with a fungicide. Cultural practices such as uprooting and burning infected parts could help.

Downy Mildew

Sorghum downy mildew occurs as either systemic or localized infection. The systemic form is induced when the pathogen colonizes the meristematic foliar tissues. Systematically infected seedlings are chlorotic and stunted and may die prematurely. This disease is more prevalent in medium rainfall areas. Farmers are advised to use seed that has been treated with fungicides. Most of the improved varieties are fairly resistant to this disease.

Anthracnose

Anthracnose is the most important leaf spot disease in high rainfall areas. To avoid this disease, use the recommended varieties for each region and follow the planting timing recommendations.

Ergot

Individual ovaries between the glumes of some or all sorghum florets are replaced by a soft, white, subglobose-shaped growth of mycelium (sphacelium) from which sticky, liquid droplets of spore-bearing honeydew (thin to viscous, orange-brown or superficially white) may exude. Under conditions of high relative humidity, the copious honeydew is thin and the surface white. The surfaces of the panicle, leaves and soil become smeared by the dripping honeydew and appear conspicuously white. A white, powdery crust forms wherever such honeydew dries. Can be a serious problem in hybrid seed production where male sterility is used.

Cultural control is not always reliable, often depending on the capricious nature of the climate. Crops may escape ergot if early rains permit sowing in November so that flowering coincides with a mid-season dry spell in January or February. Sorghum is unaffected by ergot when seed multiplication is carried out under irrigation in the dry season.

Field practices that reduce the risk or severity of infection include the removal of infected panicles at harvest, 3-year crop rotations and deep ploughing of field residues. Increasing the ratio of pollen-producing rows to the male-sterile female parent, or staggering the planting dates of the pollen donor rows helps to reduce ergot by increasing the period when pollen is available but only

if the weather conditions are favourable for pollination. Cold nights 2 - 3 weeks before flowering and cool, wet weather at flowering and during the 5 days after flowering have an overriding negative effect on all systems, promoting disease.

Pests

Four major pests are known to cause concern:

Shootfly

Shootfly attacks sorghum plants when they are still very young. This is a common problem where there is a differential planting. Usually the second planting is attacked. The larvae feed on growing parts of the plant and causes them to die. If possible plant at about the same time.

Armoured Crickets

Armoured crickets are sporadic in nature and cause serious damage to many crops in drier parts of the region, the valleys in particular. The green coloured young crickets (nymphs) start appearing at knee-high stage and, if not controlled, damage the heads and grain. It attacks a range of crops and migrates from one crop to another. IPM strategies such as timely weeding, trenches around the field, stripping of leaves up to the flag leaf and the use of "Karate" have been found to be effective in controlling armoured crickets. Poison bait (maize meal and "Karate") around and inside the field is also effective.

Stem borers

Stem borers are pests that deserve attention. It is necessary to closely observe the occurrences of these pests and control them timely. Control measures concentrate on crop hygiene and crop rotation. A prophylactic spray with long lasting broad-spectrum insecticide like 'Fastac' is recommended at knee-high stage to protect the crop from insect-pests.

Crop Sanitation

Traditionally, crop residue is left far too long in the fields after harvest. This practice harbours diseases and insect-pests like stalk borers. It is advisable to either remove the crop residue or incorporate it into the soil by winter ploughing.

1.4.7 Rotation

Crop rotation as part of crop management can be helpful to farmers and has many advantages as follows:

- Control of pests and diseases can be achieved when crops susceptible to certain diseases and pests are alternated with those that are either resistant or non-host.
- Efficient utilisation of soil nutrients by alternating crops which differ in their relative requirements of certain nutrients or those that differ in depths of rooting systems.
- Weed control can be achieved by alternating with crops that differ in canopy cover. Certain weeds are associated with certain crops e.g. witchweed.
- Improving soil fertility by alternating crops that tend to exhaust the soil with those that enrich it e.g., cereal legume rotation.

1.4.8 Harvesting

The grain reaches physiological maturity when the spot where the grain attaches to the inflorescence turns from green to black. Where birds are a serious problem, heads can be harvested at this stage and dried on floors or racks. A combine harvester can be used to harvest the sorghum or it can be done manually. Hand harvested heads can be threshed by a stationary combine, hand beating or by using cattle to walk on the layers of sorghum heads.

1.4.9 Storage

Sorghum should be stored in mud-plastered bins in threshed form and not in heads because this way the crop is more at risk to storage insects and rodents. Hard grain varieties store better and longer than soft-grained varieties. It is advisable to consume soft-grain types first and store hard grain types for later use. Dried grain must be stored in closed bins treated with “Blue Cross”.

1.4.10 Uses

The nutritional composition of sorghum is not very different from that of other cereals such as maize (Hulse et al. 1980). The most important consideration of sorghum is whether it has tannins or not. The tannins or polyphenols are nutritional inhibitors as the tannins combine with proteins making them undigestible.

In Zambia and indeed in most countries in southern Africa, milled sorghum flour is used for nshima or ugali. White grain varieties are preferred. In the valleys farmers eat the grain when it is still in the grain milk dough stage as a snack. Another important use of sorghum is in the brewing of alcoholic and non-alcoholic beverages. Several varieties listed above such as MMSH – 375 and 413 are ideal for such purposes.

Sorghum can also be used in the livestock feed industry. Forage sorghum such as FSH-22 and Sima can be used as silage and hay by livestock owners.

Table 1. Sorghum varieties released in Zambia

Variety/Hybrid	Main Attributes
Kuyuma	Early, short, white grain variety with tan plants and excellent milling properties; widely adapted to low rainfall areas with good resistance to all important diseases in Zambia, except for anthracnose
Sima	A medium-tall, medium-late, white grain variety with juicy and sweet stocks for dual purposes - grain and forage; well adapted to all three agro-climatic regions of Zambia and moderate resistance to all diseases.
MMSH-375	Widely adapted in Zambia and the region; high potential, brown grain hybrid with moderate levels of tannin and good resistance to all diseases of Zambia except for Downy mildew.
MMSH-413	A widely adapted in Zambia and the region; high potential brown grain hybrid with higher tannin content and excellent malting properties; resistant to most diseases.
ZSV-12	A semi-photo period sensitive, pigmented white grain variety with good resistance to soil acidity and anthracnose; well adapted to high rainfall areas.
FSH-22	A multi-cut high tillering forage sorghum for silage, hay and green chops; low HCN content and high leaf - stem ratio.
MMSH-1324	A tan, early, medium-height, white grain hybrid with good grain quality on tan plant and high yield; widely adapted to dry areas; resistance to all diseases except for anthracnose
MMSH-1257	A widely adapted high potential tan, medium-tall, medium-maturity, white grain hybrid with wide adaptation and good levels of resistance to most diseases; recommended throughout the country
ZSV-15	A widely adapted white grain variety of excellent grain quality and good levels of resistance to all diseases - an improvement over Kuyuma variety for the drier areas.
WP-13	A photo-period sensitive, high potential pigmented white and large-grain land race variety with good resistance to soil acidity and adaptation to high rainfall areas.

Chapter Two
Pearl Millet

2.1 Introduction

Pearl millet (*Pennisetum glaucum*), commonly known as bulrush millet, is the most drought and soil acidity tolerant cereal (Singh et al 1980; National Academy 1996). It belongs to the grass family graminae. It grows on poor sandy soils and within a range of rainfall from 350 to 700 mm per annum. It can withstand long spells of drought. Pearl millet is able to regenerate and produce new basal tillers to compensate for losses caused by drought or other unfavourable conditions. This crop is, therefore, the most assured cereal crop of drought high-risk areas.

Pearl millet can grow up to a height of 3.0 metres. Its root system is not as extensive as that of sorghum. Pearl millet tillers also flower and produce grain. The head which is a dense cluster of small flowers is compact and cylindrical and may be tapering in some varieties. It is largely a cross pollinated crop with a small percentage self pollinating.

Pearl millet is used as food in different forms as well as in making sweet and alcoholic beverages. The overall nutritive value of pearl millet grain is better than most cereals as it contains higher amounts of fat (4.5 - 5%), minerals and essential amino acids such as lysine and tryptophane. The use of pearl millet in stock feed is also common in many countries. Pearl millet stalks are stiff and strong and commonly used in the construction of traditional houses, fences and other structures.

2.2 Varieties

Several varieties with different attributes have been released to farmers in Zambia that have a wide adaptation (Table 2).

Kaufela
Plant height is 2.5 - 3 m
Maturing in 90 - 105 days (early)
Long thin heads (25 - 35 cm) with dark grey grains
Larger grains than Local
Mean yield potential is 2.4 tons/ha
Adapted throughout pearl millet growing areas

Lubasi
Plant height: 2.0 - 2.2 m

Maturing in 95 - 110 days (early)
Large, short compact (20 - 30 cm) heads with dark, light grey grains.
Mean yield potential: 2.6 tons/ha
Adapted throughout Pearl Millet growing areas.

Sepo
Plant height: 2.6 - 3 m
Maturing in: 115 - 125 days (late)
Thin and cylindrical long (30-35 cm) heads with mixture of creamy yellow and light grey grains
Mean yield potential: 2.8 tons/ha
Adapted in Pearl millet growing areas of Regions Ib and IIb.
It is suitable for early planting on sandy and acidic soils

Tuso
Plant height: 2 - 2.8 m
Maturing in: 110 - 120 days (late)
Mean yield potential: 2.8 tons/ha
Adaptation: Region II

Kuomboka
Plant height 2 - 2.8 m
Maturing in: 110 - 120 days (late)
Mean yield potential: 2.8 tons/ha
Adapted in Pearl millet growing areas of Region II

2.3 Soils – Water and Soil Requirements

Pearl millet can be grown in all three agro-ecological zones of Zambia. It can grow on a wide range of rainfall and soil types. However sandy or light loamy soils are best for pearl millet. A combination of low rainfall (350 - 700 mm per annum) and high surface temperature (30 - 40 C) increases growth rate. A rich well-drained soil is ideal. However, the crop is normally sown on poor, light-textured soils in semi-arid areas. The crop can extract nutrients and water from dry and low fertility soil. It is tolerant to low soil pH and salinity.

2.4 Management Practices

For a good harvest the following cultivation practices should be followed:

2.4.1 Seedbed Preparation

Pearl millet like sorghum needs a fine seedbed for planting, as the seeds are small. A fine seed bed is critical where the seed has to be broadcast. How-

ever, plant seeds 2 - 3 cm deep. Deeper plantings may lead to poor germination. Weeds should be removed so that seeds are planted in a clean field.

2.4.2 Planting Dates

Planting in Region IIb should be from mid-November to mid-December (as per availability of rains). In Region I planting can be as late as first week of January. In a normal situation, the crop should be planted with the second and third good rain. Early dry planting is not recommended. However, dry planting can be practiced for the Sepo variety as it is late maturing and was developed from local germplasm that has been subjected by farmers to dry planting practices.

Seed Rate

3 - 4 kg ha^{-1} or 1 kg/Lima

Planting Method

Pearl millet requires a well prepared seedbed with a fine tilth. Lighter soils are best for this purpose. Generally pearl millet is intercropped with other crops such as beans, cowpeas etc. It is also sown in pure stands. Seed is either broadcast or sown in hills 45 cm x 45 cm to about 100 cm x 100 cm apart. In Zambia, studies have shown that 5 - 8 seeds per station at 60 cm x 60 cm spacing at a depth of 2 - 3 cm achieve the desired results. In extremely dry areas, wider spacing should be used. In case of mechanical cultivation, planting at 75 cm between rows and 20 cm between plants is recommended. Time of planting varies with locality and should be done with the first rains in dry areas. It is advisable to plant when the soil is moist to achieve better germination and better plant population.

Thinning

After 15 - 20 days of emergence, extra plants from each station must be removed leaving 2 - 3 plants per station or one plant every 20 cm in case of row planting. Thinning should be done before the seedlings start producing secondary branches (tillers). Excessive plant density adversely affects the plant growth and yields. If the weather is favourable transplanting can be done to fill the gaps.

2.4.3 Use of Fertilizer

New varieties are responsive to improved soil fertility. Grain yields are substantially increased with low dose of fertilizers. In fields with mature kraal manure there is no need of any fertilizer in the first year. However, as fertility declines use of fertilizers is beneficial. The normal dose of fertilizer recom-

mended for pearl millet is 100 kg ha^{-1} of "D" compound as basal and 50 kg ha^{-1}a of urea as top dressing. For organic fertilisers see sorghum above.

2.4.4 Weed Control

Weeding should be done to prevent weeds from competing with the crop for moisture and nutrients. Weed control can be done either with a hoe or a cultivator. Wide row spacing allows use of mechanical cultivators. Because pearl millet plants grow fast, one weeding is normally sufficient.

2.4.5 Birds

In certain areas birds can be a serious problem on pearl millet just like in many other grain crops especially on isolated fields near forests or water points in early maturing varieties and late planted fields. Birds must be scared away, starting at early stages of grain development to full maturity when grain becomes hard. Bird damage in any one field can be reduced if many farmers plant varieties of similar maturity at the same time. There is no genetic resistance against birds in pearl millet although varieties with bristles, hairs or awns can tolerate grain damage or loss due to birds.

2.4.6 Crop Protection

There are several diseases of economic importance that attack pearl millet. Most of the varieties released are fairly tolerant to these diseases that occur in Zambia which include:

Downey mildew (Sclerospora graminicola), appears like leafy brush in the place of a spike. Rust (Puccinia substriata Var. indica) and a complex of leafspots reduce forage quality. The improved varieties have adequate resistance to the above-mentioned diseases.

Control: Use of resistant varieties and fungicide seed dressing.

Ergot (Claviceps fusiformis) and smut (Tolyposporium penicillariae) are the main diseases of economic importance on traditional local varieties in Zambia. For smut and ergot infected pearl millet florets, ovaries are covered into structures called sori (singular sorus). The sori are larger than grains and appear as

enlarged, oval to conical bodies projecting somewhat beyond the glumes in place of grains.

Control: Dress seed with fungicide. Control of smut include crop rotation and destruction of the infected heads and crop residues after harvest.

Insect Pests

The most serious pests of pearl millet include shoot fly, stem borer, armoured crickets and birds.

Control: For shoot fly and stem borers plant early. Avoid planting late in the areas where these pests are known to occur. Insecticides such as karate can control armoured crickets effectively. Insecticide can be applied as a spray or as bait.

Wild Millet and Shibra

Pearl millet crosses freely with its wild related species producing a hybrid called Shibra that has no economic value. Shibra plants should be removed from the field as soon as they can be identified preferably before flowering. They are a reservoir of diseases and contaminant to seed crops.

2.4.7 Rotation

The basic principle of cereal/legume should be followed and the field left fallow the fourth season.

2.4.8 Harvesting

Harvesting should be done as soon as the crop is mature to avoid losses from storms and birds etc. Harvesting should be done either by cutting the peduncles with knives or secateurs. Combine harvesting is possible on dwarf hybrids. The heads should be fully dried to facilitate threshing, which can be done mechanically.

2.4.9 Storage

The grain should be cleaned, dried and stored in bags, drums or other containers to reduce damage from storage insects. The grain for seed should be stored in sealed air-tight containers.

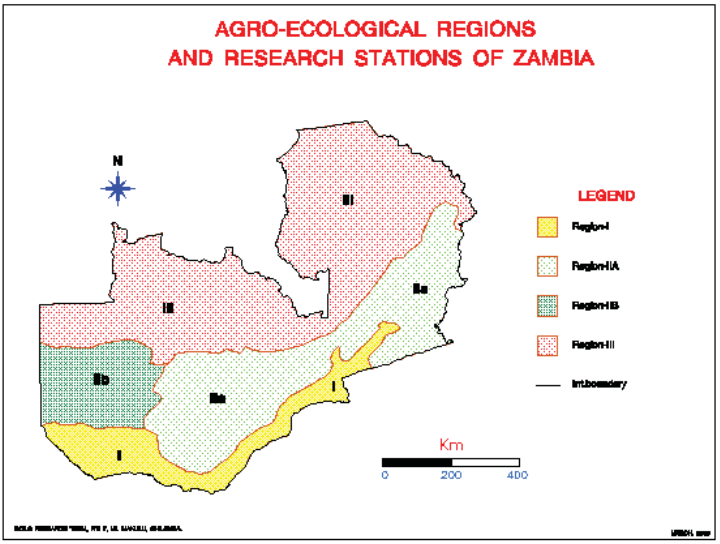
2.4.10 Uses

Pearl millet is used in the same way as sorghum and maize. Pearl millet milled flour is used to make nshima or porridge. It is also a popular grain for local beer and non-alcoholic beverages with peasant farmers. In certain circumstances the stalks can either be fed to livestock or could be used as a fence. Commercial utilisation of pearl millet grain is yet to be developed.

Table 2. Pearl Millet varieties released in Zambia

Variety	Main Attributes
Kaufela	Plant height is 2.5 – 3 m. Maturing in 90 – 105 days (early); Long thin heads (25 – 35 cm) with dark grey grains; Larger grains than Local; Mean yield potential is 2.4 tons/ha; Adapted throughout pearl millet growing areas.
Lubasi	Plant height: 2.0 – 2.2 m; Maturing in 95 – 110 days (early); Large, short compact (20 – 30 cm) heads with dark, light grey grains; Mean yield potential: 2.6 tons/ha; Adapted throughout Pearl Millet growing areas.
Sepo	Plant height: 2.6 – 3 m; Maturing in:115 – 125 days (late); Thin and cylindrical long (30-35 cm) heads with mixture of creamy yellow and light grey grains; Mean yield potential: 2.8 tons/ha; Adapted in Pearl millet growing areas of Regions Ib and IIb.; It is suitable for early planting on sandy and acidic soils.
Tuso	Plant height: 2 – 2.8 m; Maturing in: 110 – 120 days (late); Mean yield potential: 2.8 tons/ha; Adaptation: Region II.
Kuomboka	Plant height 2 – 2.8 m; Maturing in: 110 – 120 days (late); Mean yield potential: 2.8 tons/ha; Adapted in Pearl millet growing areas of Region II.

Figure 1. Agro - ecological regions of Zambia



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