KALRO
Kenya Agricultural & Livestock Research Organization

KCSAP
Kenya Climate Smart Agriculture Project

Napier Grass Seed Business Manual

KCSAP Extension Manual No. 4

Production of Napier grass cuttings and splits

Ayako W., Kidula N.L., Ndungu-Magiroi K.W., Koech M.N., Nguru J., Mathai N., Nyambati E.M., Chelimo E. and Mbugua D.

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The information presented in this manual is for advisory use only. Users of this book should verify site-specific details that relate to their agro-climatic zones from their area agricultural extension officers.

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FOREWORD

Kenya Climate-Smart Agriculture Project (KCSAP) tasked the Kenya Agricultural and Livestock Research Organization (KALRO) with the implementation of the project's Component 2 on 'Strengthening Climate-Smart Agricultural Research and Seed Systems'. The component was implemented through several subcomponents that developed, validated, and delivered context specific climate smart agriculture (CSA) technologies, innovation and management practices (TIMPS). Besides delivering on CSA TIMPS, KALRO and her NARS partners have further unpacked the TIMPs through the development of Training of Trainers (ToT) Manuals and Extension Training Manuals for dissemination and upscaling of TIMPs. Through the information and knowledge in the Extension Manuals, farmers will leverage on the TIMPs developed and therefore enhance their productivity.

The contents in the manuals are arranged progressively, supported by extensive information from research and background data. The Manuals design takes into consideration the delivery system, the knowledge, information and its logical flow. Similar content requiring similar delivery systems are grouped together, while the roles of the partners are tapped in the training and planning of the training sessions. The Manuals are arranged into sections, which have a uniform outline that ensures every aspect of the TIMPs are fully covered in way that the users can absorb and relate to. Various delivery methods are deployed and where possible demonstrations and practical work are incorporated to enable the trainees learn by participating in the actual field activities.

Through the sub-component on 'Strengthening Climate Smart Agriculture Research and Seed Systems', the scientists also developed sustainable seed production and distribution systems for priority value chains, to enhance availability and access to improved seeds, animal breeds and fingerlings by target beneficiaries. The scientists have further developed other manuals on specific 'seed' that describe production and management including gross margins of the enterprises of producing the seed material. The information in these manuals is a valuable resource for both public and private sector service providers and farmers. The use of this Napier Seed Production Manual is expected to enable the achievement of the envisaged 'Triple Wins' of increased productivity, enhanced resilience and reduction of greenhouse gases emissions.

I am greatly indebted to our scientists and all those who participated in the preparation of this Manual, which is expected to deliver current information and knowledge in a changing agricultural environment.

Eliud K Kireger, PhD, OGW

Director General, KALRO

PREFACE

The Kenya Climate-Smart Agriculture Project (KCSAP) project development objective (PDO) as outlined in the PAD is "to increase agricultural productivity and build resilience to climate change risks in the targeted smallholder farming and pastoral communities, and in the event of an Eligible Crisis or Emergency, to provide immediate and effective response." This objective is to be achieved through the implementation of five key components, which are 1) Up scaling Climate-Smart Agricultural Practices, 2) Strengthening Climate-Smart Agricultural Research and Seed Systems, 3) Supporting Agro-weather, Market, Climate, and Advisory Services, 4) Project Coordination and Management and 5) Contingency Emergency Response.

Component 2 implemented by KALRO is tasked with the responsibility of providing Technologies Innovations and Management Practices (TIMPS). It supports the development, validation, and adoption of context specific CSA TIMPS to target beneficiaries under Components 1 and 3 as well as development of sustainable seed production and distribution systems.

To catalyze uptake of TIMPs, KALRO in conjunction with partners in the National Agricultural Research Systems (NARS) and Consultative Group for International Agricultural Research (CGIAR) compiled inventories of TIMPs for the prioritized livestock value chains namely; apiculture, indigenous chicken (meat and eggs), dairy (cattle and camel), red meat (cattle, sheep and goats) and aquaculture. Also, there are two (2) cross cutting themes on pastures and fodder, and animal health.

The TIMPs were categorized into those ready for upscaling and those requiring validation. Furthermore, gaps that required further research and development of TIMPS were identified. Training of Trainers' (ToT) manuals focusing on TIMPs that were ready for upscaling for each of the value chains were subsequently developed to form the basis of training county extension staff, service providers and lead farmers. Those trained were in turn expected to cascade the training to beneficiaries in the targeted smallholder farming, agro-pastoral and pastoral communities in the 24 project counties of Marsabit, Isiolo, Tana River, Garissa, Wajir, Mandera, West Pokot, Baringo, Laikipia, Machakos, Nyeri, Tharaka Nithi, Lamu, Taita Taveta, Kajiado, Busia, Siaya, Nyandarua, Bomet, Kericho, Kakamega, Uasin Gishu, Elgeyo Marakwet and Kisumu.

KALRO has been instrumental in using its information resources and those of partners and collaborators to develop information resources that support the upscaling and dissemination of TIMPs. Some of these resources are Manuals, Hand Books, Resource Books, pamphlets and brochures whose objective is to unpack the TIMPs information and knowledge for wider usage by the farming community as well as the extension staff.

We are grateful to all who participated in the development and production of this Napier Seed Production Manual. It is my hope that users will put this information resource to good use to make the livestock value chain more productive and resilient while minimizing GHG emissions under a changing climate.

Jane Wamuongo, PhD

KCSAP Livestock Coordinator, KALRO

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We are also grateful to the contributors of this manual who include KALRO scientists and extension agents.

Abbreviations and acronyms

CA	Conservation Agriculture
C.A.N	Calcium Ammonium Nitrate
CIGs	Common Interest Groups
CP	Crude Protein
DM	Dry Matter
FCRI	Food Crop Research Institute
GM	Gross Margin
GMA	Gross Margins Analysis
KALRO	Kenya Agricultural and Livestock Research Organization
KCSAP	Kenya Climate Smart Agriculture Project
LU	Livestock Unit
m.a.s.l	Metres Above Sea Level
NPK	Nitrogen Phosphorus Potassium
PO	Producer Organization
T.S.P	Triple Super Phosphate
TIMPS	Technology Innovation Management Practices
TR	Total Revenue
TVC	Total Variable Costs
VMGs	Vulnerable and Marginalized Group

1.0 INTRODUCTION

NAPIER GRASS (*Pennisetum purpureum*)

Napier grass is a robust perennial grass with vigorous root system and creeping rhizomes. It is one of the most important forages producing high yield per unit area of land. Generally, it is fed directly to livestock or made into silage or hay. It produces huge biomass and can be harvested multiple times within a year. The recommended cutting frequency is 8-12 weeks depending on the weather and management practices. The fodder is most popular and widely grown by small scale dairy farmers in Kenya. There are several varieties of this crop. Napier grass variety Kakamega I is one of the varieties that has been promoted by KALRO due to its high yield, tolerance to snow mold, stunting and head smut diseases. It prefers deep, fertile loam soils and does well in different Agroecological zones. The variety has a higher growth rate compared to other Napier grass varieties.

Napier grass forms the basal feed for dairy animals and the yield from an acre is enough to feed 1 Livestock Unit (LU) an equivalent of 1 milking cow, 1 heifer and 1 calf for a year. The average Dry Matter (DM) yield ranges from 12 to 25 tons per hectare per year (4.8 -10 tons per acre). The nutritive value of Napier grass is Crude Protein (CP) 7-9%, 22% DM and 30% Crude Fiber. The yield and nutritive value depend on soil fertility, rainfall and management practices.

1.1 Napier grass varieties

The varieties of Napier grass developed and promoted in Kenya include Kakamega 1 and 2 and 3, Bana grass, French Cameroun, Clone 13, Pakistan Hybrid, Uganda hairless, Ouma 1 and 2 and South Africa. These varieties are commonly grown by dairy farmers in the country. Kakamega 1 and 2, Ouma 1 and 2 and South Africa varieties have proven to be tolerant to Napier stunting and smut diseases.

1.2 Napier grass Kakamega I

Growing of Napier grass including Kakamega I (Figure 1) is a low- risk and highly profitable enterprise. The demand for planting material is increasing. There is need to train farmers on how to grow and commercialize Napier grass production using root splits and cuttings (canes). These are the only planting materials available since Napier grass does not form seeds easily. It is possible to get 190,000- 200,000 canes per acre/year (475,000 – 500,000 canes per ha/year).

Figure 1: Napier grass Kakamega I at 8 weeks after establishment

This manual provides information on how to produce, manage and utilize Napier grass Kakamega I for seed production as a business.

1.3 General Agro-ecological requirements

Napier grass does well in high potential and medium potential areas although it is also grown in zones I, II, III and semi-arid areas. Its main agroecological requirements are:

- Minimum rainfall: 900 mm
- Grows well up to an altitude of 2000 m from seal level
- Performs very well at temperature ranging from 25 to 40 degree Celsius
- It is sensitive to frost and water logging conditions
- Soil pH: 5 –8, deep, fertile friable loam, well drained soils.

2.0 FIELD ESTABLISHMENT AND MANAGEMENT

a). Land preparation

Land/seedbed can be prepared using either conventional or Conservation Agriculture (CA) methods. Conventional methods include hand cultivation, use of an ox or tractor plough and harrowing. "Tumbukiza" is a CA method of Napier grass establishment.

Plough and harrow the field well before planting. Napier grass planting requires primary ploughing followed by 1st and 2nd harrowing to make a seedbed with a fine tilth (Figure 2). Remove all the trash from the field (Figure 3).

Figure 2:Primary and secondary land preparation

Figure 3: Picking of trash from the seedbed

b). Fertilizer and Manure application

Apply approximately 8 tons of farm yard manure and 50 kg of compound (NPK 20:20:0) fertilizer per acre (125 kg/ha) at planting. In case where farm yard manure is unavailable, use 100 kgs of NPK (20:20:0) fertilizer per acre (250 kg/ha). Apply 100 kg of nitrogenous fertilizer (CAN 26%N) per acre (250 kg/ha) per year for top dressing after the second cutting. Where available, apply slurry manure regularly after every subsequent cutting.

2.3 Propagation

Since at farm level it is not possible to harvest and use conventional Napier grass seeds as planting materials, the main mode of propagation of Napier grass is by stem cuttings (canes) or root splits. Seed in this manual will therefore refer to Napier grass splits or canes. The quantity of planting material depends on the area the farmers want to establish.

2.3.1 Inoculation of Napier canes with root enhancing hormone (organic fertilizer)

Inoculation is introduction of a bacteria or a hormone meant to accelerate growth and utilization of natural nutrients. The main methods practiced are dipping and sprinkling. When dipping, Napier grass canes/splits are immersed in a water solution containing inoculants and then transplanted in polythene bags or into a nursery covered with a net to prevent direct sunlight. For sprinkling, a polythene sheet is placed at a soil depth of 30 cm to prevent root penetration deep into the soil and conserve moisture.

Common inoculants include **HB101® or root doctor®** among others. The inoculants increase the population of microbes and enhances their activity. This helps in reducing the time taken in rooting of Napier grass and promotes healthy and faster growth. Fill up the gap of 30 cm with soil mixed with manure. Establish the cane cuttings or splits in the nursery and sprinkle with the inoculant. Rooting takes about 3-4 weeks and the rooted canes or splits are ready for planting (Figure 4).

Figure 4: Napier grass cuttings in a rooting nursery ready for planting

a). Seed Rate

Napier is planted using either the root splits or cane cuttings. The recommended seed rate of 7,500 splits or canes per acre or 18,750 splits or canes /ha is used. The different planting materials are shown in figure 5.

b). Root Splits

Figure 5: Napier grass root splits

The use of root splits is the best option to establish Napier grass (Figure 5). Root splits are obtained from mature stand of Napier grass and planted in holes spaced at 1 m apart, both along and between the rows. An actively growing rooted split with about 2 to 3 tillers is recommended for planting per hole. Napier grass root splits are suitable for planting during the rainy season.

c). Cane cuttings

Figure 6: Napier grass cane cuttings

Cane cuttings are the most convenient and common method of planting Napier grass (Figure 6). They are suitable for planting in dry areas and for dry planting. The spacing is 1 m within the rows and 1 m between the rows. The cuttings are obtained from non-diseased mature stand of Napier grass. When planting using canes, one cane cutting of 3 nodes is used per hole where two nodes are covered in the soil (Figure 7). They are planted in holes 30 cm deep and covered with soil at the onset of rains

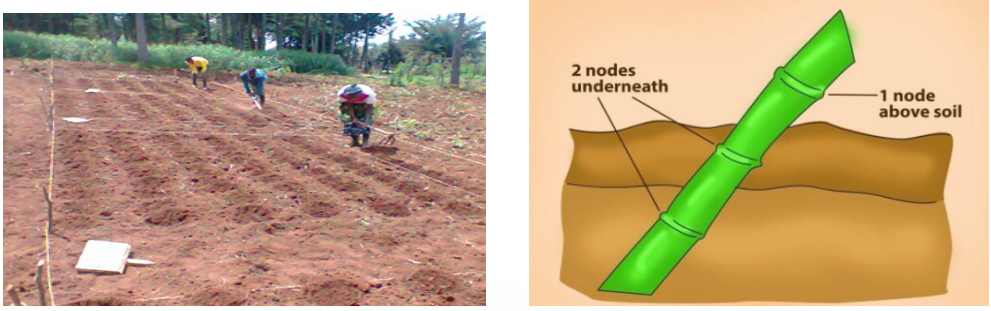


Figure 7: Making holes for Napier planting (left) depth and position of planting Napier cane (right)

2.4 Weed Management

Napier grass field needs to be weeded frequently. Weed the crop for the first time three weeks after planting and weed it at least two times before harvesting. Thereafter every subsequent cutting or when appropriate.

2.5 Pests and Diseases Management

Napier grass production is affected by several pests and diseases. The main pests affecting Napier grass are Stem borer, Leaf hopper, Mole rats and Fall army worm. While, the main diseases affecting the fodder are stunting disease, head smut and white snow mold.

Common Napier grass pests

Napier grass stem borer

Figure 8: Napier grass stem borer

This is a highly destructive pest for the Napier grass. The larvae feed on the funnels before tunneling down to feed on the developing tissues. The young plants are more susceptible to attack by stem borers. Others bore holes into the centre of the stem. This causes stunted growth, the Napier grass stem bends and is twisted making it difficult to harvest. The caterpillars then emerge to pupate.

There is no known control measure. More so, the borers do not have many natural enemies to regulate their population.

Napier grass Leaf Hopper

Figure 9: Napier grass Leaf Hopper

Leaf hoppers feed on Napier grass plants and transmit the virus that causes Napier grass stunting disease. (See Napier stunt disease Figure 12). There is no control measure but crop rotation reduces the pest population.

Mole Rat

Figure 10: Mole Rat

Mole rats burrow through the soil and feed on the Napier grass stem and roots. They often spoil more roots and stems than they actually eat.

Signs of their damage and presence include: small mounds of freshly dug soil, Napier grass leaves being pulled back down into the soil holes. They are controlled using mole traps or recommended pesticide (Fuko Kil®).

Fall army worm

Figure 11: Fall Army worm

The fall army worm is a caterpillar that eats the leaves of the plant. It is large scale invasive. In severe cases the crop is totally defoliated leaving standing stems. It can be controlled by using recommended pesticides/insecticides.

Main Diseases affecting Napier grass

Napier grass head smut

Figure 12: Napier grass head smut

Symptoms of head smut include thinner, shorter stems, fewer leaves and misshapen leaves.

The estimated yield loss due to smut disease ranges from 26 to 46%. The disease mainly spreads through wind and plant material.

Control

Grow tolerant varieties i.e. Kakamega I and use disease free planting materials. Rogue infected plants. Use recommended rates of manure and inorganic fertilizers to provide nutrients. Do not use manure from livestock fed with smut infected Napier grass.

Napier grass stunt disease

Napier grass stunt is a viral disease affecting Napier grass. It is spread by leafhoppers after feeding on an infected plant.

Figure 13: Napier grass stunt disease

Symptoms

Symptoms include stunting and yellowing as the grass re-grows after being cut or grazed. The Napier grass plant produces large number of tillers. The stunted crops eventually die.

Control

Uproot the affected plant together with soil, bury or burn. Use of more tolerant varieties such as Ouma and South Africa is recommended.

Napier grass white snow mold

Figure 14: Napier grass white snow mold

Napier white snow mold is a fungal disease common to all Napier grass varieties except Clone 13. However, this disease is not a threat to herbage production.

NB. *It is not recommended to sell disease or pest infested Napier grass planting materials since this would enhance disease spread.*

4.0 HARVESTING, STORAGE AND GROSS MARGIN ANALYSIS

4.1 Harvesting of planting materials

Napier grass as animal feed is ready for harvesting 3-4 months after planting and harvesting can continue at an interval of 6-8 weeks for 3 - 5 years. Leave a stem length of 10 cm from the ground at harvesting.

For planting canes, it takes about 6 -7 months to first cutting of canes depending on weather. Subsequently cut every 5-6 months to get mature canes. The yield is approximately 190,000 - 200,000 canes per acre/year (475,000 - 500,000 canes per ha.). The mature Napier grass canes are mainly harvested using a *panga* (machetes).

4.2 Post–Harvest and Storage

After harvesting the stem cuttings (canes) or splits, they should be kept under shade to protect them from excessive loss of moisture. Alternatively, the materials should be watered using a watering can. The splits or canes can be bundled or packed into groups of 100 for ease of sale and transportation. The materials should be transported to the planting site within two days. (Figure 15).

Figure 15: Bundles of Napier Grass Cuttings ready for transportation

5.0 SEED BUSINESS ANALYSIS

5.1 Gross Margin analysis of Napier grass seed

This is a simple and reliable tool to assess the financial performance of an activity. It helps a seed farmer to make an informed decision on the enterprise. Gross margin analysis can be used as a guideline for adjusting the sale price in order to earn maximum returns (Table 1). Record keeping should be done throughout the season to track agricultural inputs, labor and operation costs as well as the seed output (yields).

Table 1: Gross margin analysis Napier grass (Kakamega I) seed

	Napier Grass Canes			
Napier grass (1 Acre)	**Units**	**No. of units**	**Cost of units**	**Totals**
Variable Costs				
Inputs				
NPK fertilizer	50 kg Bag	2	6000	12,000.00
CAN fertilizer	50 kg Bag	4	4000	1,6000.00
Rooting hormones	pcs	80	100	8,000.00
Manure	Tons	16	5000	80,000.00
Planting materials - Cuttings (canes)	pcs	7500	5	37,500.00
Baler twine	Roll	2	3000	6,000.00
Sub Total (A)				**159,500**.00
Operations				

Napier grass (1 Acre)	Units	No. of units	Cost of units	Totals
Variable Costs				
Inputs				
Heavy harrowing (hire)	Acre	1	3000	3,000.00
Light harrowing (hire)	Acre	1	1500	1,500.00
Rooting labour/bedding labour	man/days	80	350	28,000.00
Planting labour	m/days	10	350	3,500.00
1st weeding labour	m/days	20	350	7,000.00
2nd weeding labour	m/days	20	350	7,000.00
Top dressing labour	m/days	10	350	3,500.00
Cutting labour - Harvesting	man/days	100	350	35,000.00
Post-harvest activities labour	man/days	30	350	10,500.00
Sub Total (B)				**103,000**.00
C. Total variable costs (A+B)				**262,500**.00
D. Revenue	pcs	190,000	5	950,000.00
E. Gross margin (D-C)				688,000.00
Total Revenue (TR)	pcs	190,000	5	950,000.00
Total Variable Costs of production (TVC)				262,500.00
Cost of production per split				1.38
Gross Margin (GM=TR-TVC)				688,000.00
Gross Margin % (GM/ TR*100)				72.40%

Where GM- Gross Margin TR- Total Revenue and TVC- Total Variable Costs

5.2 Using Gross Margin to determine the sale price of farm produced seed

To determine the sale price of Napier grass seed, the farmer should consider demand and supply dynamics, location, cost of production among other factors. Prices can be determined by first assessing the unit cost of production.

Unit Cost of Production = Cost of Production per Acre (Yield)/ production per Acre

In the example above, when the farmer sells seed at KES 5 per kilo, a return of approximately KES 688,000 is expected per year. The total cost of producing one split is KES 1.38. Therefore, a seed farmer can sell one split at a cost higher than KES 1.38 to make a profit.

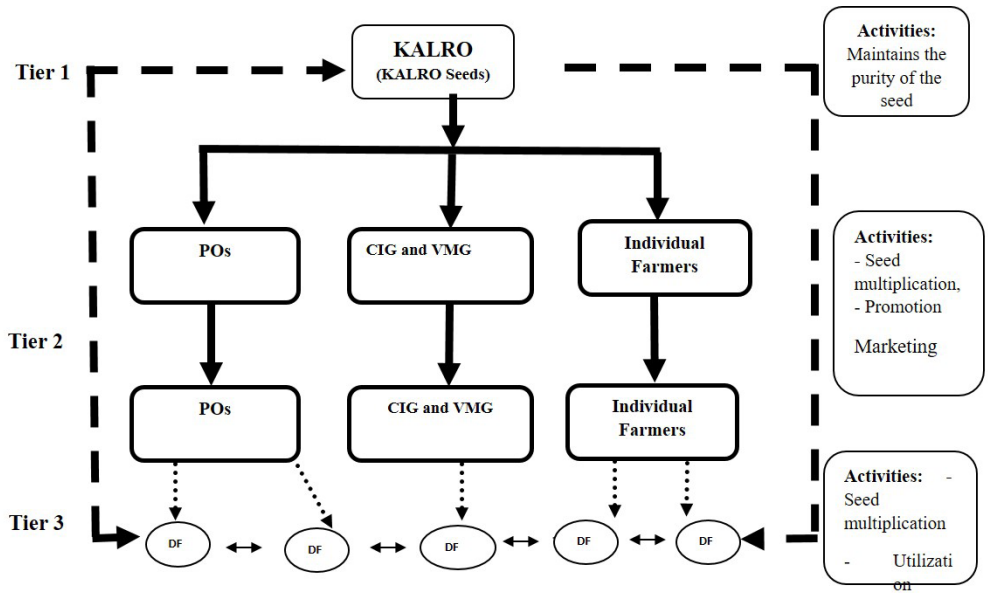
A high gross margin indicates a farmer is making money on the seed enterprise while a low margin indicate that the revenue from the enterprise is marginal. A negative gross margin indicates the revenue from the output is lower than the inputs and therefore the

need to review the entire enterprise to find out which inputs / activities take the largest cost and where reductions could be made.

The % gross profit margin indicates how efficiently a farmer is using resources to produce the seed. High gross profit margin will show that a farmer is making money on the seed enterprise while a low margin will indicate that the sale price is not much higher than the cost. Generally, for a good business, the threshold gross profit margin should be above 20%.

5.3 Napier Grass seed business model

The farmer needs to ensure that supply of clean seed material and demand for the farm produced seed is created in a sustainable manner. One model to ensure sustainability of the seed production enterprise is by use of a distribution/ marketing model that encourages diffusion of the Napier grass seed to reach the target farmers. Under the KCSAP seed project, a three-tier system of seed production was used. The first Tier involves production at research level (e.g in KALRO) which avails seed to satellite seed multipliers referred to as Tier 2. This comprises mainly community based seed producers e.g POs, CIGs, VMGs and lead farmers. Tier 2 become a source of clean planting materials to dairy farmers referred to as Tier 3 as shown in Figure 16.



Where: PO- Producer organization; CIG – Common interest group; VMG – Vulnerable and marginalized groups, DF – dairy farmers

Figure 16: Napier grass seed business model

5.4 Creating demand for Napier grass seed

For successful marketing of seed, farmers and farmer groups need to focus on some basic marketing principles which include product, price, place and promotion. This helps farmers decide on the product and its characteristics, set the price, and decide how to distribute and promote it. This is based on the following marketing principles;

- Product: what to produce? Napier grass canes. The potential customers have to be convinced that the product will be of value to them and suitable for their needs as animal feed.
- Price: at what price to sell? The price of one split in 2022 is KES 5 which is determined mainly by the cost of production and demand. However, demand has to be created. Once consumers are convinced, the producers can supply the product through negotiated price putting in to consideration the production costs of the seed. The price should not go below the cost of producing one split, otherwise the farmer will make losses.
- Place: where to sell it? Farmers can sell the splits amongst themselves, other CIGs, VMGs, POs and other institutions. As demand is created the producers have to ensure adequate supply to satisfy the created demand.
- Promotion: how to promote the product? This can be achieved using avenues such as farmer to farmer interactions, churches, schools, shows, milk collection centers and use of printed materials. In addition, promotional campaigns in farmer to farmer extension, field days, and agricultural shows, through demonstration, County extension staff and social media platforms such as Facebook, WhatsApp etc are among other avenues that farmers can use to market their seed.

5.0 FURTHER READING

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