**Original Research Article**

# EVALUATION OF MOST APPROPRIATE PROPAGATION MEDIA FOR REGENETRAION OF PINEAPPLE SEEDLINGS FROM PINEAPPLE CROWN LEAVES


## Abstract

Pineapple cultivation is the main income generating activity in Magarini Sub-county and is grown under rain-fed conditions by small scale farmers. It significantly contributes to food security and sustenance of livelihoods in these marginal areas where rainfall reliability is a major challenge. It does well in specific soil niches found in certain natural vegetation that covers over 20,000Ha of which only less than 5% has been exploited. The land in these soil niches cannot sustainably support other annual crops except cassava due to limited rainfall and poor soils. It therefore became necessary to expand pineapple cultivation to fully utilize this enormous land potential. However, the main limiting factor was inadequate availability of clean pineapple planting material. Use of tissue culture for mass production of planting material was hindered by huge capital outlay for establishing a tissue culture laboratory. This necessitated introduction of technology on rapid mass regeneration of planting material from crown leaves which are plenty and a waste hazard. It therefore became necessary to find out the most appropriate locally available propagation media for raising seedlings from crown leaves at the comfort of farmers in their homes. A randomized complete block design experiment with four replications was set up among four pineapple growing farmer groups where each group was a replication. Each group tested four types of propagation media, namely Coir dust (as the standard propagation media), Soso and Sokoke soils (as the locally available soil media) and a mixture of Chitosan and coir dust, (being tested for its high nutrient content). Each media was contained in plastic propagation trays that constituted the experimental plots. The farmers cut and hived off at least two leaves with a bud from crowns earlier selected from healthy fruits in the market and farms. These leaves were treated with pesticides and fungicides against pests and disease pathogens then dipped in a solution of Auxin rooting hormone at 33% concentration, then planted in the respective test media in the plastic containers. The results, as evaluated by the participating farmers showed that Coir dust and Soso soil had the highest success rates of germination and emergence of pineapple seedlings, of between 50% to 75%, followed by Sokoke soil which resulted in success rates of between 14% to 60%, while Chitosan had the least at between 4% and 35%. However, farmers discounted Coir dust on account of its high cost and availability, settling on Soso soil as their best choice of propagation media for raising pineapple seedlings.


Key words: Pineapple, propagation media, Soso and Sokoke soils, Magarini Sub-County

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## 1.1Background information

Pineapplecultivation has been the main income generating activityin Magarini Sub-county after cassava, maize, simsim, cowpea, and cashewnut.It is grown under rain-fed conditions mainly by small scale farmers.Pineappleproduction significantly contributes to food security and sustenance of livelihoods in these marginal areas where rainfall reliability is a major challenge [1]. This important cash crop is produced in specific soil niches found in certain natural vegetation that spreads over 20,000Ha of which only less than 5% has been exploited[2][3]. The land in these soil niches cannot successfully sustain production of other cultivated annual crops except cassava due to limited rainfall and poor soils. Tofully exploit this land potential, it became necessary to expand pineapplecultivationsincethe fresh sweet fruits are in high demand especially in local and export markets and also for juice processing [4]. The mainlimiting factor to full exploitation of this land resource has been inadequate availability of clean pineapple planting material to farmers in the region[3]. According to [3]over 90% of farmers in these areas use about 10,000pineapple suckers per acre as planting material.However, to obtain a single sucker (or split)for planting,it takes 18 to 24 months, from planting to fruit production since mature suckers are produced when the fruit is about to be harvested. This is too longa period for farmers to wait.The use of tissue culture was an option but the capital outlay for establishing a tissue culture laboratory and the necessary infrastructure was beyond the regions capability. It therefore became necessary to introduce a technology of rapid mass generation of planting material from crown leaves since a single crown has about 70-100 leaves each of which has a potential to become a seedling for planting. It is in this regard that it became necessary to find out the most appropriate locally available propagation media for raising pineapple seedlings from crown leaves at the comfort of farmers in their homes.

## 1.2 Methodology

**1.2.1 Study site**: The study was conducted in four of the six pineapple growing areas of Magarini Sub-county by community based organization (CBO) groups in Chamari, Changoto (Adu-Mbuuni), Faith and Bore-singwaya, from November 2023 to February 2024. These groups were far removed from each other and separated by a distance of between 10 km to 30 km, with Changoto being the farthest.These pineapple growing areasarelocated about 110-120m ASL and at longitudes 39° 55' 34" Eand latitudes2° 59' 15" S [5].The regionexperiences bimodal type of rainfall where the most reliable rainfall occurs during the October to December season while the second rainfall (unreliable) occurs during April to May season[6]. Four types of soils are found in the region, namely Soso, Sokoke, Ngama and black cotton soils[3]. The Soso soils are mainly sandy in nature, free draining, whitish-grey in color and withlimited amount of organic matter. Soso soils tends to cake and formshard surface crust which inhibits water infiltration and percolation when dry. These soils mainly support cassava and tree crops. The Sokoke soils are mainly clay loam in nature, well developed, deep (4-8m) and reddish-brown in color[3].They have good amount of plant nutrients and tend to compact when waterlogged due to their high clay content. These are the pineapple growing soils and tend to be found in certain specific native vegetation. These soils support cassava growing, fruit tree crops such as cashew nut, pawpaw, citrus, mango among other tree crops. The Ngama soils are brown in color and mainly clay in nature. They tend to be sticky and slippery when wet and hard to work on when dry. The Black cotton soils have comparable characteristics to Ngama soils only that they are black in color[7]. Both Ngama and Black cotton soils are good for annual crops such as maize, green gram, cowpea, cotton, among other crops.

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### 1.2.2Experimental design and treatments

A randomized complete block design experiment replicated four times was set up.The aim of the experiment was to evaluatewhich of the locally available soil media can supporthighestrate of germination and emergence of pineapple seedlings by counting the number of days it would take for 50% of the plantings to emerge above the media surface.The treatments comprised of four media, namely Soso soil, Sokoke soil, Coir dust and a mixture of Coir and Chitosan. Soso and Sokoke soils were chosen because they are locally available in all the six pineapple growing areas of Magarini Sub-county while Coir dust was chosen because it is cheap, readily available in Coastal region and is widely used as astandard propagation media[8][9]. Chitosan a product of bat droppings mixed with coir dust, was chosen for its high levels of nutrients especially nitrogen and therefore a possible candidate as a soil amendment[10]. The experiment was carried out in each of the four groups during their group's meeting days of Monday (Chamari), Tuesday (Bore-singwaya and Faith) and Thursday (Changoto). Each group acted as a replication and therefore the experiment was replicatedfour times. Each group had a set of four plastic trays (measuring 40cmx25cm x15cm) filled with the respective media to a depth of 10cm (Plate1).

*Plate 1: Experimental plastic propagation trays per group of farmers for raising pineapple seedlings from crown leaf cutting.*

Each tray represented an experimental plot. Since each group had a membership of 20 members, five members of each group were assigned to take care of each plot (tray) in terms of:cutting and preparing the leaf cuttings from pineapple crowns and planting themin the prepared propagation media, watering, weeding and collecting data on seedling emergence up to the end of the experiment when the seedlings attained a height of 10cm (Plate 2).The experiment lasted eight weeks.

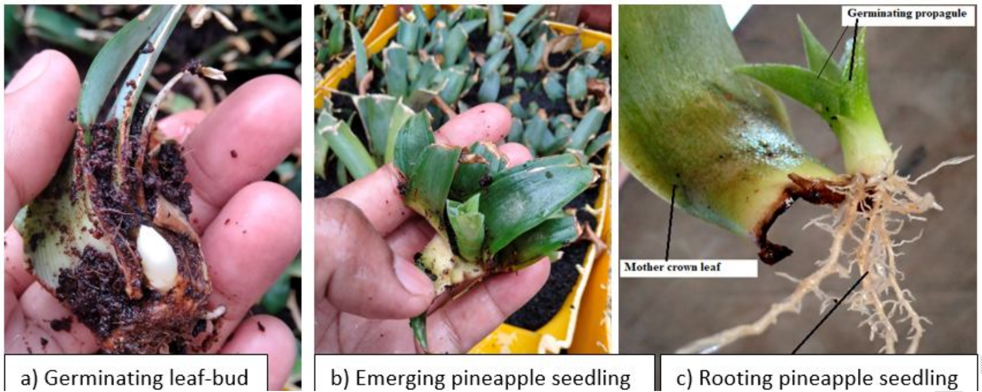


*Plate 2: Germinating leaf bud, emerging pineapple seedling and rooting seedling attached to mother crown leaf.*

### 1.2.3 Media preparation

Soso and sokoke soils were obtained from the nearest vegetated areas that had not been cultivated. These soils were crushed to obtain coarse tilth, impurities removed by hand and placed in respective plastic trays then watered two days before planting to allow for the media to settle. Leaf cuttings were prepared by cutting and hiving off at least two leaves with a bud from the crown.Two leaves were hived off because the leaf buds occurred at the basal and distal overlap between two adjacent leaves.These leaf cuttings were then dipped in a fungicide (Ridomil) to control any fungal pathogens) and then in a pesticide (Duduthrin) to control anypests. Finally, these treated leaves had their cut base surfaces dipped in auxin solutionrooting hormone (of 33% concentration) (Plate 3). These treated leaf cuttings were then planted to a depth of 3cm in the respective media in plastic trays (Plate 1).These trays were taken outside in the open sun and placed on racks raised one meter above the ground to prevent attack by stray chicken, other livestock or pests (Plate 3).

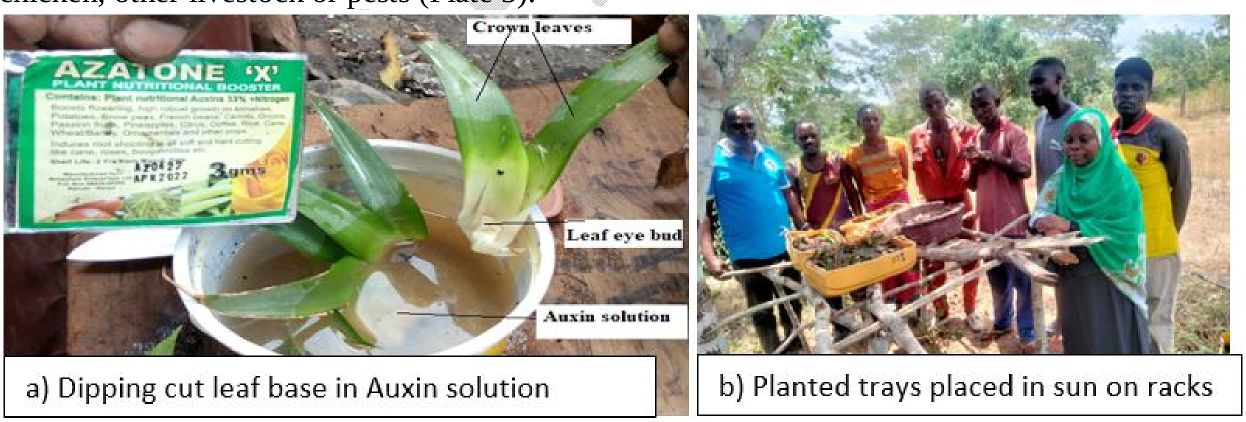


*Plate 3: Treatment of cut leaves with Auxin solution and placing planted trays on racks in open sun for germination.*

Watering was done daily during the evening hours and any weeds noted manually removed. Daily weather conditions in terms of temperature, rainfall, wind conditions and solar radiation were recorded. Being a dry season, no rainfall was recorded during the experimental period.

### 1.2.4 Data collection

Data collected includedtotal number of planted crown leaves, number of seedlings that successfully germinated and emerged above the media surface, number that had died or dried,

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media that had the highest number of germinated and emerged seedlings, andmedia that had the least number of emergedseedlings.It is the leaf bud in each leaf that germinated to give a seedling. The percentage of germinated and emerged seedlings to number of planted leaves gave indication of the success rate of germination in the different propagation media (Table 1).

## 1.3 Results and discussions

### 1.3.1 Evaluation of groups'performance and success rates on germination and emergence of pineapple seedlings

The success rates on germination and emergence was obtained by comparingthe number of planted leaf cuttings to number of germinated and emerged pineapple seedlings per plot. The first emergence of the pineapple seedlings was recorded on the third week after planting and the final tally on emergence was concluded on the sixth weekafter planting(Plate4).Table 1 shows that the total number of planted crown leaves varied for each group.

*Plate 4: Participatory process of evaluating the best germination media for pineapple leaf cuttings by counting successfully emerged seedlings.*

This variation was occasioned by differences in the number of group members who were present and participated in the practical on propagation of the pineapple seedlings and also by differences in the ability of the group members to master the art of cutting and hiving off at least two crown leaves with buds.The results indicate that the success rate of germination in the different propagation media (as given by the percentage of germinated and emerged seedlings to number of planted leaf cuttings) was varied for the different groups (Table 1). Thesevariations were attributed to the ability of the individual group members to master the art of precisely cutting and hiving off at least two crown leaves with a bud and also consistency in availability of ample water supply for watering the seedlings during the entire experimental period. Bore-singwaya, Faith and Changoto groups were far removed from water sources and had to purchase water for their domestic use and watering the pineapple nurseries. Besides they had no water storage tanks. Only Chamari and Danisa had water storage tanks for harvesting rain water, hence the observed higher success rates on germination and emergence in Chamari. Danisa and Baricho-Mwanazi groups did not participate in the study. Thus, availability of water greatly influenced the outcome of germination and emergence success rates, even though the trend in proportional rates of emergence due to the different media remained comparable (Figure 1).These observations are in agreement with [11] who reported that seed germination varies with amounts of soil moisture applied and that optimal water supply was essential for improved germination and establishment of seedlings.On germination outcome, it is the bud on each leaf that germinated and emerged above the soil to produce a seedling (Plate 2).The overall average success rate of emergence was highest in Chamari group at 58%, followed by Changota and Faith groups both at 34%, and Bore-singwaya at 18.8% (Table 1).

| **CBO group** | **Planted/germinated and emerged** | **Media** | | | | **Totals** |
|---|---|---|---|---|---|---|
| Chamari | | **Coir dust** | **Soso** | **Sokoke** | **Chito-mix** | |
| | No. Planted | 79 | 72 | 124 | 115 | 390 |
| | No. germinated | 60 | 54 | 74 | 40 | 228 |
| | % success | 76% | 75% | 60% | 35% | 58% |
| Changoto (Adu-mbuuni) | | | | | | |
| | No. Planted | 49 | 48 | 74 | 87 | 260 |
| | No. germinated | 26 | 24 | 18 | 20 | 88 |
| | % success | 53% | 50% | 24% | 23% | 34% |
| Faith | | | | | | |
| | No. Planted | 35 | 32 | 30 | 25 | 122 |
| | No. germinated | 12 | 11 | 8 | 10 | 41 |
| | % success | 34% | 34% | 27% | 40% | 34% |
| Bore-singwaya | | | | | | |
| | No. Planted | 32 | 34 | 28 | 26 | 120 |
| | No. germinated | 8 | 8.5 | 4 | 2 | 22.5 |
| | % success | 25% | 25% | 14% | 8 | 18.8% |

*Table 1: Number of planted leaf cuttings, germinated and emerged seedlings in Coir dust, Soso soil, Sokoke soil and chitosanpropagation media by the four CBO groups.*

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### 1.3.2 Evaluation of success rates on seedlings emergence for individual farmer groups

The results indicated that in Chamari group, Coir dust and Soso soil media had comparable rates of successful germination and emergence at 75% and 76%, respectively which was significantly higher than that of Sokoke and Chitosan at 60% and 35% respectively (Figure 1 and Table 1). During evaluation session by Chamari farmers,they made some inferences from the results after taking into account the cost and qualities of each germination media.That, even thoughCoir dust had the best qualities as a propagation media and resulted in highest success rate on germination and emergence (Figure 1), they ruled it out as a choice of propagation media on account of its high cost, of ksh. 2000/= per 20kg bag. Soso and Sokoke soils were locally available at no cost. Thus, since Soso soil supported the highest rate of successful germination and emergence at 75%

compared to Sokoke soil at 60%, farmers unanimously selected Soso soil to be their choice of propagation media for pineapple propagation nurseries. The qualities that made Soso soil to be a good candidate for propagation media just like Coir dust were enumerated by farmers as: loose soil particles that offered more air spaces and therefore a large capacity for storing soil moisture than all other media, high ratio of macro-pores to micro-pores which allowed free drainage, easy root penetration, aeration and appreciable water retention capacity. These observations agree with those reported by [8] who opined that use of Coir dust improves root development since it has a goodC: N ratio and high water holding capacity of about 7-9 times more than its weight, improves the porosity, water retention capacity, has good aeration, is free from pathogens and enhances quick root growth.The farmers also enumerated reasons why Sokoke soil performed poorly as nursery propagation media.That,although Sokoke soil was rich in nutrients due to its clay content compared to Soso soil, it compacted during dry spells, making it difficult for germinating seedling roots to penetrate deeper into the soil resulting in the observed short underdeveloped roots (Plate 5). This was attributed to the fact that Sokoke soil had more proportion of clay content compared to Soso soil.The clay particlesin Sokoke soil cementedthe soil particles together making it more compact and hard during dry spells.This in turn impaired root penetration, resulting in poor seedling growth. This explains the low success rates on germination and emergence recorded by Faith and Bore-singwaya groups where water availability and therefore watering was inconsistent.

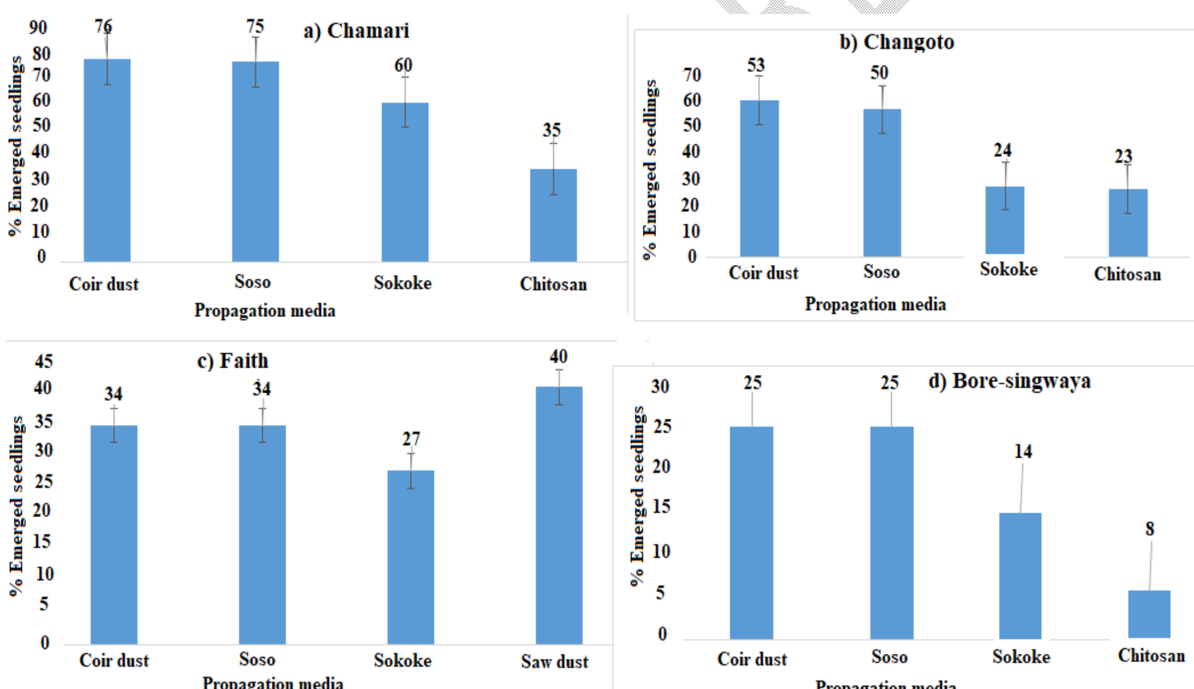


*Figure 1: Percent emergence of pineapple seedlings due to different propagation media*

Similar observations were made by [12] who showed that soil strength and compaction influenced root growth and distribution whichreducedplant's ability to uptake water and nutrientsresulting in reduced growth and yield. The inconsistentwatering resulted in low germination and emergence rates (Figure 1). The farmers identified qualities that made Soso soil best propagation media as having loose soil particles, more macro-pores and therefore more air spaces and which allowed aeration, free water drainage, easy root penetration, and appreciable water retention after watering. Comparison of root sizes and lengths of seedlings grown in Coir, Soso and Sokoke soils showed that seedlings grown in loose media such as Coir dust and Soso soilhad many, longer and fibrous roots than those grown in compact Sokoke soils (Plate 5 and Figure 1).According to [12]soil strength or resistance to root penetration is determined by its bulk density and moisture content status. This resistance increases as the soil becomes drywhich in turn increases resistance to root growth.Reduced root growth limits ability of plants to access nutrients and water resulting in reduced plant growth. Chitosanhad the lowest success rate of 35% (Table 1 and Figure 1).The low germination and emergence rates observed in Chitosan was attributed to rotting of most leaf-cuttings.This rotting was probably due to incomplete decomposition of the organic material in Chitosan where the C: N ratio of the media was critically high. Extremely high C: N ratiossuggested that the media had more carbon than available nitrogen which implied that much of the nitrogen in the media was initially utilized and immobilized by the microbes in the media for their growth and little was left available for plant growth and metabolism. This resulted in the observed death of germinating plantlets, underdeveloped roots and yellowing of seedlings (Plate 6d).According to [13]different C: N ratios change soil bacterial community, diversity (species richness) and activity. All these attributes ameliorate soil nutrient status and conditions,and in the process provides benefits to soil bacterial communities and subsequently to root and plant growth.In Changoto, Faith and Bore-singwaya groups, the pattern of germination and emergence of pineapple seedlings was similar to those observed in Chamari, especially for Coir dust, Soso, Sokoke and Chitosan media.They only differed in magnitude of germination and emergence rates. Thus, in Changoto the success rates of germination and emergence in Coir dust and Soso media were 53% and 50% respectively, which were significantly higher than that of Sokoke and Chitosan at 24% and 23% respectively.


*Plate 5: Roots sizes of pineapple seedlings grown in Sokoke (compact) and Soso (sandy) soils*.

Comparable results were also obtained by Bore-singwaya group, where Coir dust and Soso soil media had similar germination and emergence success rates of 25%, while Sokoke had 14% and Chitosan the least at 8%. In Faith group, Chitosan was substituted with Saw dust which was readily available in local wood workshops. The Saw dust media resulted in highest germination and emergence success rates at 40%, much higher than that of coir dust and Soso soil media both at 34% (Figure 1). Thus, this group unanimously resolved that Saw dust was the most suitable media for use in pineapple propagation nurseries and that in its absence, Soso soil was the second most suitable media for propagation. They rejected Coir dust due to its high cost and poor availability. Sawdust media was observed to be more porous but with high water holding capacity, fairly free draining and allowing for aeration and faster root growth and elongation.

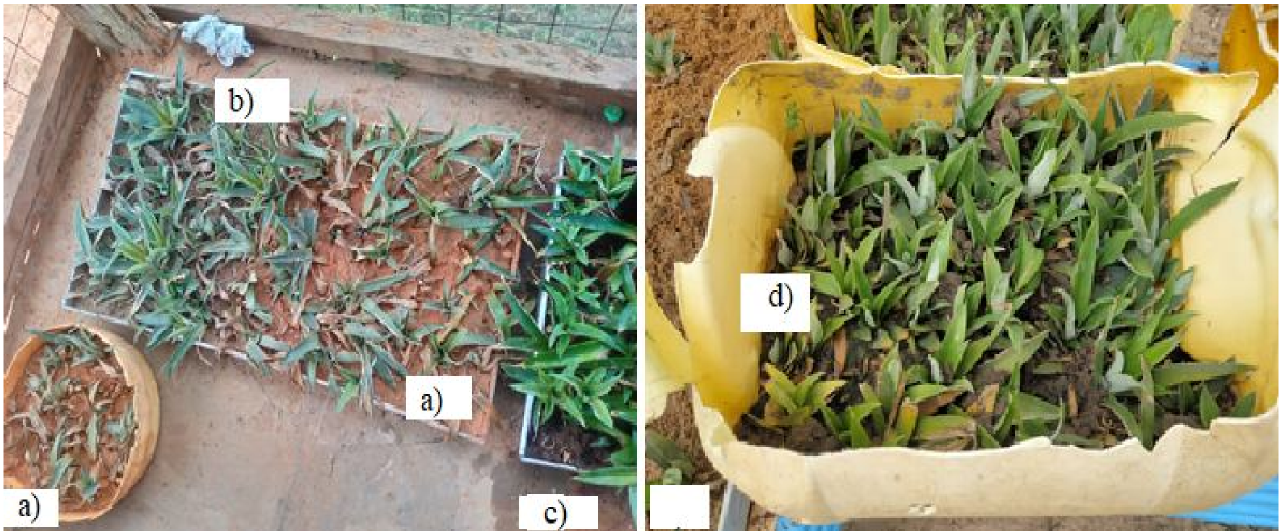


*Plate 6: Pineapple seedlings germinating in: a) Sokoke soil; b) Soso soil; c) Coir dust and d) goat manure.*

This was unlike sokoke soil which formed a hard surface crust and compacted soil horizon when dry, making root growth difficult and resulting in stunted plants (Plates5a and 6a). Therefore, in all the four groups farmers gave similar observations on the performance of the different media on germination and emergence rates of pineapple seedlings. Thus, while the farmers had indicated that there were no significant differences in germination and emergence success rates between Coir dust and Soso soil media, they had reservations on adoption and use of Coir dust. Coir dust had to be bought, while Soso soil was obtained locally at no cost. Therefore, farmers unanimously agreed that Soso soil was the most cost effective and thus most suitable as propagation media for raising pineapple seedlings from crown leaves in their nurseries.

**1.4 Conclusion**

The study based on farmers' evaluation of the results has shown that Coir dust and Soso soil media gave the highest and comparable success rates on germination and emergence of pineapple seedlings regenerated from crown leaf cuttings (with buds) of between 50% to 75%. In the study, Coir dust was used as a standard media of propagation for purposes of helpingto screenand identify the most suitable media for use in propagationnurseries among the locally available propagation media resourcesin Magarini Sub-county, namely Soso soil, Sokoke soil and Saw dust (for case of Faith group). In this regard therefore, Soso soil which is essentially sandy loam soil was identified and singled out by Magarini Sub-countypineapple farmers as the most suitable soil media for use in pineapple propagation nurseries. Sokoke soil which had germination and emergence success rates of between 14% to 60% was discounted on account of being compact and hard during temporary dry spells which hindered root penetration and development.On watering, Sokoke soil became temporary water loggedresulting in poorly developed roots and stunted seedlings. Saw dust was rated good as propagation media butwas considered as a by-product of environmental degradation and also was not readily available in all pineapple growing areas.

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