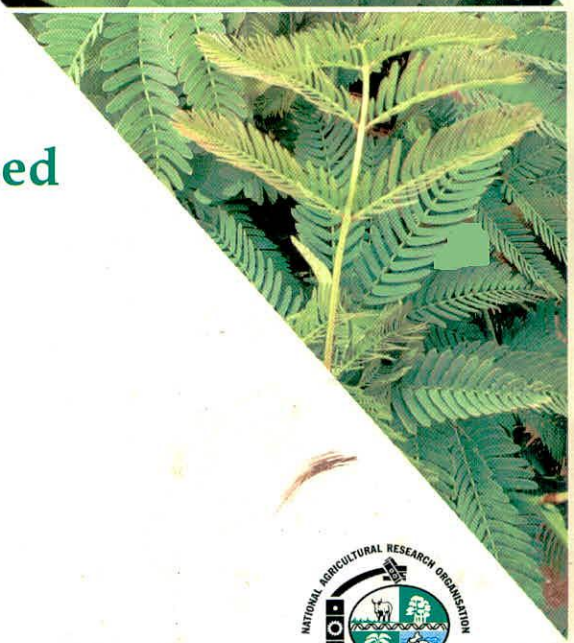


Guidelines

On-farm Pasture Seed Production



Agricultural Sector Programme Support

ASPS Danida

NATIONAL AGRICULTURAL RESEARCH ORGANISATION

NARO



FOREWORD

Pasture seed is a key resource for pasture improvement. The scarcity of pasture seed results into unproductive pastures which translate into poor performance of ruminant livestock. Poor performance in this case would be in terms of low milk yields, low liveweight gains and low fertility rates. The livestock sector in Uganda, which is dominated by ruminants, contributes significantly to the economy of Uganda. It is a source of livelihood for numerous households where it serves as a source of income and human nutrition. It is imperative therefore that ruminant productivity is promoted through increasing availability of required resources, in this case pasture seed.

Production of pasture seed in Uganda has not received much attention partly due to the inadequate information on the techniques used in the process. These techniques in some cases are quite different from those used in crop production. These guidelines have been developed to address the scarcity of pasture seed in the country. It is expected that as more farmers acquire the skill of pasture seed production and begin to explore the practice. There will be increased availability of pasture seed which will, subsequently, result in improved pastures on farms in the country. This will greatly support cattle and goat production in the country and increase their contribution towards household incomes and nutrition as well as the national economy. These guidelines are also aimed at motivating the private sector, particularly seed production companies, into considering pasture seed as one of their products. Contracting farmers to undertake the field phase would be an effective demonstration of beneficial farmer and private sector partnerships that could, infact, be emulated in other areas of production.

The information presented in this book had been obtained partly from field activities carried out in different sites. The sites included farmers' fields, District Agricultural Training and Information Centres (DATIC) and the National Crop Resources Research Institute (NaCRRI). The information in this book is expected to provide a platform upon which farmers and seed producers will launch successfully into the field of pasture seed production. In this way they will provide one of the major resources for ruminant livestock production.



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1. INTRODUCTION

Availability of pasture seed is critical in livestock production. It is necessary for development of productive grazing pastures particularly to support dairy production which is extremely demanding in terms of feed resource requirement. However, in Uganda there is shortage of pasture seed due to absence of a pasture seed production scheme. Existing seasonal pasture seed stocks, produced by small-scale farmers, are often very limited in quantity. Small quantities of seed may also be present at the National Agricultural Research Organisation (NARO) Institutes, particularly, the National Crop Resources Research Institute (NaCRRI) in Namulonge, the National Livestock Resources Research Institute (NaLIRRI) in Tororo and the National Semi-Arid Resources Research Institute (NaSARRI) in Serere. The scarcity of pasture seed also renders them costly and hence unaffordable for most farmers. As a result, farmers fail to improve their pastures and depend on natural pastures which cannot produce the desired levels of livestock productivity. For instance, poor pastures will lead to poor milk yields, poor growth rates, poor conception rates and poor calf birth weights. Efforts to identify strategies to ensure availability of pasture seed identified on-farm pasture seed production as a viable option for overcoming the seed scarcity constraint. A few farmers have been trained in pasture seed production skills, however, they do not form a critical mass and more need this training. The development of a "Pasture Seed Production handbook" was seen as an ideal starting point for getting farmers into the practice. There are six major steps observed in proper pasture seed production namely (i) Identifying sites and selecting choice of pasture types (ii) Land preparation and planting (iii) Field management (iv) Harvesting and processing (v) Seed conditioning and packaging and (vi) Profit- Loss analysis. These are outlined in the following sections.

2. IDENTIFYING SITES AND CHOICE OF TYPES OF PASTURES

Land should be far from interference of grazing animals and if this is not possible fencing should be done to avoid destruction of the crop by animals. The soils in the area should be well drained and not water logged such as in swampy areas. Pasture species selected must be favoured by the climatic conditions of the area (Table 1; Plates 1-6). Furthermore, the types should be marketable in the area e.g. do not produce seed for paddock pastures when most farmers in your area are practicing the zero-grazing system. Farmers should also consider the compatibility of crop types on their farms with specific pasture types. Seed production for the smaller legumes such as Siratro and Centro could be done in banana plantations which will not be the case if one would like to produce elephant grass cuttings.

Table 1. Pasture species and favourable climatic conditions

PASTURE SPECIES	COMMON NAME	RAINFALL ADAPTATION	TEMPERATURE
Grasses			
Chloris gayana	Chloris/Rhodes grass	600 - 1200	Warm and cool
Panicum maximum	Guinea grass	780 - 1800	Warm
Pennisetum purpureum	Elephant grass/Napier	1000 - 1500	Warm and cool
Legumes			
Macroptilium atropurpureum	Siratro	800 - 1600	Warm
Centrosema pubescens	Centro	750 - 1800	Warm
Lablab purpureus	Lablab	1000 - 2500	Warm and cool
Stylosanthes guianensis	Stylo	1000 - 2500	Warm and cool

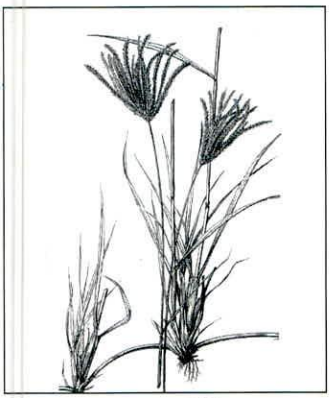

Plate 1: Chloris



Plate 2: Panicum

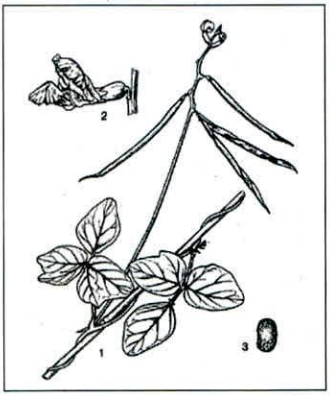

Plate 3: Siratro

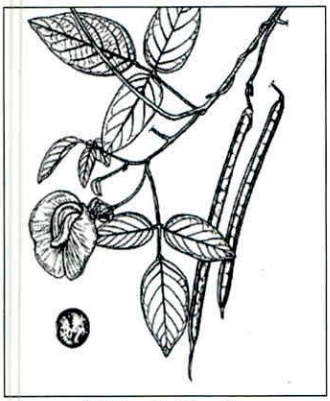

Plate 4: Centro



Plate 5: Stylo

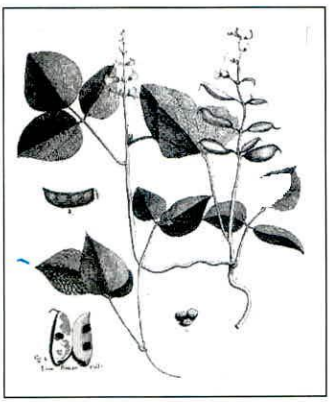

Plate 6: Lablab

3. LAND PREPARATION AND PLANTING

Newly-cleared land is often used for pasture seed production to ensure less competition from weeds and other pasture plants. This is particularly important with some of the less competitive legumes where less fertile land is used. Herbicides such as "Round-up" may be used to kill all weeds and weed seeds. New stands planted in old weedy fields are likely to produce low seed yields in the first year.

3.1 Fertilizer Application

Fertilizers if applied should be evenly distributed across the field. On less fertile soils, 50 kg of nitrogen per hectare should be applied to grasses at establishment but this dressing can be reduced or eliminated when the soils are considered fertile. This rate of nitrogen amounts to 100 kg if urea is used or 200 kg if nitrogen proportion of a fertilizer is 25%. In terms of dry cattle manure this amounts to about 3500 kg. Phosphate fertilizers may be applied for legumes, which in form of SSP is applied at a rate of 100 kg per ha. Where dry cattle manure is used for providing phosphorus application rate of 8300 kg per ha is used. In the case of legumes, fertilizers should not be mixed with seed at the time of sowing as this can result in interactions which reduce germination and inoculant effectiveness. Fertilizers or manure can be mixed with the soil prior to planting. For grasses, fertilizer application is best done after tillering.

3.2 Time of Sowing

Planting should be done at the onset of the rains. Row planting is most appropriate to enable early weeding and enhance general management of the crop.

3.3 Choice of Planting Material

Seeds or vegetative material may be used for planting. Seeds are used for pasture types which produce readily available viable seeds such as *Chloris gayana, Panicum maximum, Centrosema pubescens, Macroptilium atropurpureum* and *Lablab purpureus*. On the other hand, vegetative materials are used for pasture types where seed is not available or when the germination ability of available seed is poor. These materials may be in the form of rhizomes, stolons, root splits or stem pieces or cuttings and are genetically identical to the parent plant. These methods are used for propagation of elephant grass (Napier grass), Brachiaria and in some cases for Desmodium species.

3.4 Seeding Rate

As an approximate guide, seeding rates for forage seed crops should generally be at least twice those recommended for normal pasture sowings. Sowing rate for grasses will range from 6-10 kg per ha and for legumes 2-6 kg per ha. In the case of grasses, shallow furrows are made in the field with a stick and the seed are dropped by hand letting out a few seeds at a time along the furrow. The seeds are then covered lightly with soil using a rake or tree branch. Spacing of 60cm (2ft) may be left between rows. Legumes should be planted in rows by dropping about 4-6 seeds per hole for the small legumes such as Centro and 2 seeds per hole for the large legumes such as Lablab. Spacing between rows for small seeded legumes may also be 60cm and between holes within the rows 30cm (1ft). Spacing for lablab is 1 m between rows and 1 m between plants/holes within the rows.

With higher sowing rates, the need for later "thickening up" of the seed stand should be minimal. Lower seeding rates are recommended for row planting compared with broadcast sowing. However, the temptation to save too much should be resisted as it could lead to a sparse, weedy stand producing low seed yields in the early years. If low quality seed has to be used e.g. seed of good genetic quality but of low germination percentage and low purity, the sowing rate should be increased.

3.5 Vegetative Planting Material

These were introduced in section 3.3 of this handbook and in this respect the discussion will concentrate on elephant grass. Cane cuttings are often planted in the case of elephant grass, however, splits could also be used. Cuttings are obtained from mature plants when the stems still have green streaks. Each cutting should have 3-4 internodes and the cut at each end should be made at an angle hence presenting a slanting edge. The slanting edges of the cutting prevent habouring of water after planting which would have caused the cutting to rot. In addition, the slant promotes development of leaves from the buds. At planting 2 internodes are pushed into the soil while the rest are left above the surface. It is important that at planting, the cuttings are positioned with the buds facing upwards. This is done to ensure that developing leaves emerge in the correct orientation. If the buds are pointed downwards, the leaves will emerge pointing downwards towards the soil.

3.6 Spatial Arrangement and Plant Density

Proximity to already established materials may result in growth being retarded by shading and drying out because of root mass. Annual plants must re-establish every year and some control of plant density may be necessary if seed production is not to be reduced. Similar considerations also apply to perennial plants which lack vigour. Seed areas should be renovated and re-established when seed production starts to decline.

3.7 Depth of Sowing

One of the commonest causes of failure in establishment of small-seeded species is sowing too deeply. Sowing seeds deeply will lengthen the period between planting and emergence from the soil as food reserves in the seeds will not be adequate to sustain the seedling throughout this period Since most pasture plant seeds are relatively small, they are generally sown on the surface of the soil or incorporated to not more than 1 cm depth.

3.8 Establishment Problems

Several problems relating to establishment are often faced by farmers involved in seed production.These problems generally fall into four types. These are:

- Physical loss of seed due to predators (eaten or removed)
- Loss of seed viability due to environmental stress
- Failure of germinated seed to emerge from the soil due to environmental stress
- Mortality of emerged seedlings due to environmental stress, plant competition or pathogen or pest attacks.

4 CROP MANAGEMENT

The overall aim of management, whether for grasses or legumes is to produce high yielding seed crops. Pasture species have been bred mainly for their forage potential (i.e. production of leaf and stem) not for seed yield. Consequently, the harvest index (i.e. seed to shoot ratio) may be very low and yields are seldom more than 1 tonne per hectare. The local environment sets the broad growing conditions which are then manipulated through management to meet the needs of particular crops. The management of grasses and legumes differ markedly.

4.1 Management of Grasses

Management of grasses is aimed at promoting the development of large numbers of seed heads in as short a time span as possible for synchronisation. Synchronisation in seed production is successful when the majority of seeds attain maturity at the same time. The major practices to promote this strategy are defoliation by cutting or grazing and application of nitrogen (N) fertilizer (50 kg of N per ha). This combination encourages the production of many new tillers or shoots in the first few weeks of regrowth, providing the basis for synchronized seed maturation. Many other factors such as irrigation, pests and diseases and crop perenniality also affect the development of seed heads.

4.1.1 Defoliation

A cleaning cut is usually made at the beginning of each cropping cycle. This cut reduces old vegetation and, with the aid of nitrogen (50 kg per ha), encourages the development of the tillers on which the seed heads will eventually be produced. There are generally two main aspects of defoliation to consider, namely severity and timing.

To reduce severity, the bulk of stubble from the previous crop should be removed by cutting or grazing at the beginning of season, which enables the final cleaning cut to be lenient or less severe and results in faster regrowth and tiller development in some species. Heavy or severe defoliation in some grasses such as Callide Rhodes restricts crop growth resulting in slower and more prolonged head emergence.

4.1.2 Nutrient Requirement

Nitrogen fertilizer is of crucial importance in post establishment crop. Not only the rate but especially the time of application has an overriding effect. Without N fertilizer there is little chance of having a good seed crop after the 1st year of harvesting. Nitrogen is essential to bring on many heads and effective spikelets, while high plant density is necessary to promote the synchrony of their action. Consequently, N is the factor most responsible for the quality of seed, while narrow row width is instrumental in raising the percentage germinating seed (% PGS).

4.2 Management of Forage Legumes

The first objective in developing a legume seed crop is to close the crop canopy as soon as possible, certainly before flowering is initiated. This

provides the necessary vegetative structure to maximise seed production. There are generally three groups of legumes available, namely warm tropical, cool tropical and subtropical legumes. Seed management differs within these groups as a result of their temperature adaptation. Here we focus on warm tropical legumes, which are adapted to most of the Ugandan environment.

4.2.1 Warm Tropical Legumes

Most of the "true" warm tropical legumes need a frost-free site for seed production. In others, such as *Macroptilium atropurpureum* (Siratro) and *Centrosema pubesscens* (Centro), moisture stress is used to promote vigorous reproductive growth. There is therefore the need for a climate with reliable and well-defined wet and dry seasons. A four-to six-month wet season allows most tropical legumes to produce the necessary strong vegetative framework for a heavy seed crop. An average annual rainfall of at least 800 mm generally provides sufficient moisture, with an upper limit of 1500 - 2000 mm.

4.2.2 Defoliation

Legume crops are usually cut back at harvest and then allowed to build up gradually through the growing season without any further cutting or grazing. Excessive growth, however, can be a problem if they are allowed to grow unchecked for the full growing season, for example, stylo, a vigorous short-day legume, produces a tangled mass of stems more than two metres long. Such crops gradually subside into a compact mat of stems below an undulating crop canopy with seed heads at varying levels of the canopy so that more material has to be harvested than in an even crop. Cutting the compacted mass of stems is also extremely difficult and possibly damaging for even the most powerful harvesting machines. For these reasons, stylo crops need to be cut back during the vegetative phase to control their growth. To avoid any reduction in yield, defoliation must be done early enough to allow complete recovery of the canopy before the first flowers are initiated.

4.2.3 Staking or using Trellises

Staking is the provision of vertical support for creeping and climbing legumes. This can be done using sticks (Plate 7) or using trellises (Plate 8) comprised of timber poles and wires in between as often done for passion fruits. Trellises are more effective and long lasting than the sticks, however, they are more costly. Staking increases seed yields by as much as two times in forage legumes.



Plate 7: **A field of *Centrosema pubescens* where staking has been done in Kamenyamigo DATIC, Masaka.**

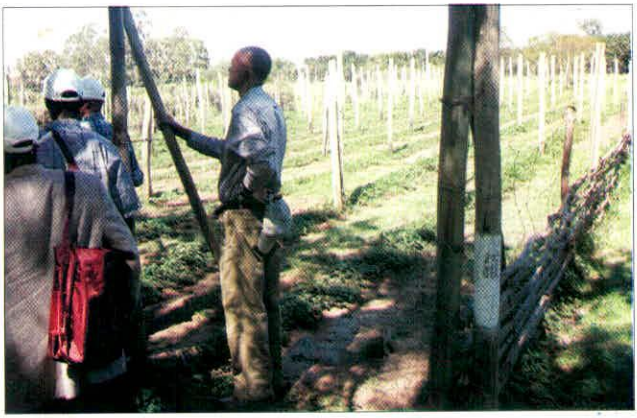

Plate 8: **Trellis structure before the legumes begin climbing.**

4.2.4 Irrigation

Irrigation strategies vary in different legume crops. In Siratro and Centro, for example, flushes of seeding can be induced by alternating periods of irrigation and moisture stress in areas with a reliable dry season. Care should be taken not to leach out soil nutrients by over watering.

4.2.5 Weed control

Weeding should be done 3 weeks after planting and thereafter once a month. However, this depends on the amount of rainfall during the period. With frequent rains the weeds regrow within a short period and therefore

weeding will also be required more frequently. In the case of creeping legumes, where staking has not been done, a vigorous smothering canopy is formed which will control weeds and therefore requirement for weeding will be less in advanced stages of the crop field. In other leguminous crops where a dense smothering canopy is difficult to form, weed control is obviously more difficult.

4.2.6 Pests and diseases

Tiley (1969) reported that stunting disease probably a virus, was more serious than white mould. There is possibility that there is some relation between this stunting disease and white mould. Virus problems in grasses can be reduced by roguing and spraying to reduce insect vectors.

General control measures: In seed production the initial stock seed must be free of the seed borne diseases. Control measures must be integrated to reduce incidence of the pests and disease. These measures include:

- Use of clear certified seed
- Early planting to reduce incidence of pests and disease
- Roguing of diseased plants or any suspect plants
- Good field management through control of weeds
- Crop rotation
- Removal of crop residue before next planting
- Chemical control of pests and diseases
- Timely harvesting



Plate 9: **A field of *Lablab purpureus* will require spraying with pesticides after flowering occurs.**

5 HARVESTING AND PROCESSING TECHNOLOGIES

5.1 Signs of Seed Maturity

In tropical pasture seed crops, the choice of harvest time is a complicated decision because some immature seeds will always, be present. Even the most closely synchronised crops comprise inflorescences (flowers) in various stages of maturity and there is further variation in flowering time within individual inflorescences. For a particular crop, the period in which high yields of ripe seed can be harvested depends on the species or cultivar involved, weather conditions and harvest method. In practice approximately 25-50% of the potential yield is available because of continuous production and loss.

The decision to harvest the crop depends on what the heads looks like. All indicators for harvest are somewhat subjective; therefore, for accurate assessment there is no substitute for experience aided by keen observation. Seed moisture content, endosperm hardness or seed weight can be monitored, but for all practical purposes appearance of the crop is the best factor.

5.1.1 Grasses

A number of visual indicators have been proposed for grass seed crops to fix the optimum harvesting time more closely. Timing also depends on weather conditions, because wind and rain can strip seeds from the inflorescence. When harvesting large areas, start earlier to avoid losses.

Seeds should generally be harvested when the bulk of seed is not far from shedding. At this stage, ripening seed can be readily removed by gentle rubbing or by stroking from the base to the apex (tip) of an inflorescence. Samples should be checked to ensure that the florets contain seeds by biting individual seeds, or by rubbing in the palm of the hand to remove seeds. The seed in a floret can be felt when the floret is pressed between two teeth. Crop colour, which is a useful indicator of seed maturity, depends on changes in the pigmentation of individual seeds during maturation, and these do not occur in all crops e.g. *Brachiara decumbens* (signal grass). When a field is ready for harvest, a large number of ripening seeds are reflected in the overall appearance of the crop. In the case of *Chloris gayana* the field will have a golden colour from a distance (Plate 10). This method is more useful when crops are reasonably well synchronised. For harvest of vegetative planting material, it must be ensured that mother plants are mature but not overgrown and free from diseases. However, vegetative planting materials unlike seed can not be stored.



Plate 10: **A crop of *Chloris gayana* with the seeds almost ready for harvest at Kamenyamigo DATIC, Masaka**

5.1.2 Legumes

Legume seeds often mature from the bottom of the seed head upwards. Normally the pod colouring changes from green to yellow and later brown.

5.2 Manual Seed Harvesting

The principal tools still used by small-scale farmers in sub-Saharan Africa are the knives, sickles, scythes and reaping hooks. These tools can either be used to harvest the entire plant or, if necessary, selectively remove seed heads. The cost of these tools is minimal, they are easy to maintain or repair, dependable and are also familiar to farmers. Hand-harvesting is the simplest method and, where labour is cheap and plentiful, it is the most sensible to use.

5.2.1 Grass seed harvesting

Grass seed heads may be cut with sickles and bound into sheaths of diameter 50-60 cm. The sheaths (Plate 11) are stooked (stood) in the field or kept in a well ventilated shed or covered stand. The sheaths are collected for threshing some two weeks later. Heads are then shaken to enable all detached seeds to fall out. The seeds are then collected from the floor. Threshing is done to remove the undetached seeds and rough sieving is done to remove large pieces of chaff. Threshing can be done by beating the heads gently with a stick or allowing animals to trample over them. This will detach the remaining seeds from the heads. Threshing can also be done mechanically. Drying should not be done in direct sunlight as this may damage and kill the seeds, it should be

done in a shady area. A useful process referred to as "sweating" occurs in the stooked sheaths or when harvested heads are covered in tarpaulin sheets for about 3 days. During sweating all spikelets get detached from the heads enabling the producer to recover a higher proportion of seed. It generally gives about twice the yield of direct-heading. Sweated seed is also of very high quality because maturation can be completed in the moist conditions inside the stack or in the tarpaulin. Similar results can be achieved with direct headed seed if it is also dried properly (10% moisture or less). Sweated seed also stores very well. Seed should be spread thinly to dissipate heat and even if it gets lumpy, mouldy and grey the seed should not be damaged.



Plate 11: A stooked sheath with Chloris

5.2.2 Legume seed harvesting

With legumes it is advisable to hand pick pods when they are ready. This can be done over a long period of time in the dry season at 2 weekly intervals until all pods have been removed. Mature pods, particularly in Siratro, often shatter and seed fall to the ground and as such seed must also be harvested from the ground. Seeds harvested in pods are dried and then threshed.

6 POST-HARVEST SEED CONDITIONING

After harvest, seeds must be threshed, cleaned and dried ready for storage. Newly harvested seeds contain husks, straw, soil particles and other unwanted seeds. These must be removed through the threshing and cleaning process to obtain good quality seeds of the required cultivar. Seeds are often harvested at higher moisture contents than those recommended for storage. Moist seeds are susceptible to damage during cleaning because they are relatively soft. Drying reduces seed moisture to a safe level for both cleaning and later storage. We shall examine, in detail, each of these seed operations.

6.1 Seed Drying

Newly harvested seed of all tropical grasses and some legumes is quite moist. Freshly harvested grass seeds can have a moisture content of 40-70%. The seeds must therefore be dried to a safe moisture content (5-10%) to prevent loss of germination, heating and infestation during storage. Even seeds harvested from sheaths/stooks require further drying. Leaving the seed to dry on the mother plant is best since the seeds continue to mature and are shed naturally. However, if the crop remains in the field for too long, yields may be lowered through lodging and seed shatter, especially in wet windy areas. Increases in diseases and pests may also lower quality and remain a problem during storage.

During drying seed moisture evaporates into the surrounding air. Evaporation, using heat from the seed, occurs until the amount of water in the seed is the same with the amount in the air (relative humidity). This is termed as the equilibrium moisture content of seeds and varies from crop to crop. The rate at which a seed dries is a function of how fast the moisture evaporates from its surface. This in turn depends on the temperature and relative humidity of the drying air and the rate at which moisture moves from inside the seed to the seed surface (i.e. permeability of the seed to moisture).

There is relationship between safe drying temperature and initial seed moisture content. The general recommendation for field crops is to dry the seed at temperatures of no more than 32, 37 and 43^{0}C for moisture contents of more than 18%, 10 to 18%, and less than 10% moisture, respectively. Seed viability is decreased by drying at temperatures above 40^{0}C. If drying is too rapid there is a tendency for the seed coat to split or harden which may prevent the interior of the seed from drying.

6.1.1 Sun or shade drying

The seed is spread on a floor, racks, mats, tarpaulin (canvas sheet) etc. to dry in the sun for legumes and an open shade for grass seeds. It is important to dry seeds on a waterproof base to avoid transfer of moisture from the ground up into the seeds. At no time should grass seed be exposed to direct sunlight for drying. Temperatures under the sun often exceed 35-40^{0}C and this can kill the seed. Legumes can withstand some exposure due to their harder seed coats. Usually, the rate of drying is proportional to the exposed surface area of the layer which often means that the thin seeds that cover a large area

dry soonest. This method relies solely on ambient conditions which can dry or increase the seed moisture content depending on wind, temperature and relative humidity. Drying is faster in well ventilated areas. Seed drying is a long process and threshing, winnowing and cleaning can proceed simultaneously with drying.

Advantages of sun or shade drying

- Small quantities of seed can usually be quickly and efficiently dried in the shade.
- It is inexpensive and requires minimal supervision or attention to the seeds (turning every 1 - 2 hours).

Disadvantages of sun or shade drying

- Weather dependent
- Incomplete drying in humid environments
- Grass seed are unable to withstand the high temperatures in direct sunlight
- Seed can be blown away and lost or mixed with others unless screened from the wind.

6.2 Threshing and Winnowing

Threshing involves separating the seeds from panicles and straw, and winnowing the chaff from the seeds. The process of separating the seed from the chaff or pod often requires considerable energy but sorting the seed from the straw is a relatively easy process. This process is followed by winnowing.

6.2.1 Manual threshing

- Small-scale farmers employing this method often use a simple stick to separate the seed from the inflorescence and straw by beating the crop repeatedly on the floor.
- Animals can be allowed to trample on the harvested material to detach seeds from the heads
- The crop or plant parts bearing the seed may also be beaten against stones to release the seeds. This is the case with stylo where the pods are very small and hairy.
- Hand collection by rubbing or shaking ripe seeds into a container can provide seed of excellent quality especially when labour is effectively supervised.

In all the techniques care must be taken to minimize physical damage which can affect germination or allow disease infestation. In legumes, abrasion can reduce the degree of hard seededness.

6.2.2 Winnowing

Winnowing uses wind to separate heavy and light material. It involves dropping the material from shoulder height or higher on to a clean area on the ground with wind blowing from behind. Alternatively, flat baskets or trays may be used for winnowing. During winnowing, any material that is lighter than the seed is removed and the remaining seed is hand sorted to remove imperfect seed and non-seed material. Whether by hand or machine, winnowing is easy to handle.

6.3 Seed Cleaning

Seed cleaning is the removal of unwanted material, which may include other crop seed (including weeds) and damaged seed to increase market value. Cleaning ensures good seed quality. If done with the right equipment and appropriate methods, it can increase purity and germination by removal of unsuitable materials. It can also decrease the number of diseased seeds and improve the visual, commercial and planting quality of the seed lot. Seed cleaning can be done manually by sorting out unwanted material from small seed lots.

Seeds have three major characteristics by which they can be separated from non-seed material or other seeds. They are:

- Geometric - size (width and thickness), length and shape.
- Mechanical - resilience, shape, size, surface textures and density.
- Physical - surface texture, specific gravity and affinities.

6.4 Seed Packaging

Seed packaging must be able to protect the seed from physical, climatological and biological damage. The package therefore serves as a:

- Convenient unit of handling, purchase, transport and storage
- Protection against contamination, mechanical damage and loss
- Suitable environment for storage
- Sales promoter (information and advertisement).

Seeds are packaged in different materials and containers. In determining the kind of packaging material or container best suited, the following points need consideration:

- Quantity of seed in each package
- Quality of seed and protection desired
- Cost of the package
- Value of the seed
- Conditions under which the container is kept.

The causes of seed damage and deterioration during distribution could result from physical, climatic and biological factors. Physical effects such as cracking (at micro and macro level), bruising and separation by size and weight arise from poor stacking and handling and are caused by impact and vibrations during movement. Climatic effects result in physiological and physical damage while biological agents particularly pests and diseases cause damage and decay. Packaging can minimize the seed damage depending on the material used. The range of materials to suit different seed weights is shown in Table 2 and Plates 12-13.

Table 2: Appropriate packaging materials for different seed weights

SEED WEIGHT (KG)	PACKAGING MATERIALS
0.001 - 0.5	Paper, cotton, polythene, foil, tin
0.1 - 5	Tin, rigid paper, plastic
0 - 50	Cotton, jute (Plate 12), polythene, paper
10 - 100	Jute, hemp (Plate 13), kenaf, sisal
100 - 5000	Jute, metal, wood



Plate 12: Jute bag



Plate 13: Hemp fabric

6.5 Seed Storage

Seed is stored from harvest to the next planting, which may be in the next season or after several seasons. A number of factors influence the viability and maintenance of seed quality during storage. The most important are seed moisture and temperature.

If seed is to be stored for any length of time, it must be at safe moisture content (10%) in conditions with relative humidity of about 30%. High moisture contents allow insect and micro-organism activity, which cause heating. Maintenance of seed viability depends on the conditions experienced before and during storage. Damage during harvesting, inadequate or improper drying, rough handling and poor physical storage should be avoided. Without artificial conditions seeds can be stored for 6 months to 1 year.

7 NET MARGIN ANALYSIS FOR PASTURE SEED PRODUCTION

Net margin analyses were done (Table 3) by three separate groups of extension personnel from seven districts of Uganda attending a short training on pasture seed production. Analyses were done for Centro, Chloris and Siratro and produced positive net margins.

Cost of seeds is the same as sale price of the seeds at Ushs 6,000/kg for each Centro and Siratro and Ushs 10,000/kg for Chloris. Seed yields used are 500 kg/ha/harvest each for Centro and Siratro and 300 kg/ha/harvest for Chloris.

Table 3: Net Margin Analysis for Pasture Seed Production

EXPENDITURE ITEM	PASTURE SEED TYPES		
	Centro	Chloris	Siratro
LAND PREPARATION			
Slashing	60,000	100,000	62,500
1st ploughing	144,000	150,000	150,000
2nd ploughing	120,000	150,000	125,000
Harrowing	72,000	70,000	75,000
PLANTING MATERIALS/SEEDS			
Cost of seeds	43,200	120,000	30,000
Sisal string	3,000	5,000	-
Hoes (2 @ 3500)	7,000	-	-
Fertilizer	120,000	-	-
Inoculum	3,000	-	7,500
Labour for planting (in rows)	72,000	50,000	75,000
1st weeding	96,000	150,000	100,000
2nd weeding	84,000	100,000	80,000
3rd weeding	72,000	70,000	80,000
Staking- cutting cassava stems for stakes)	144,000	-	-
Labour	72,000	-	-
MANURE & FERTILIZER APPLICATION & SPRAYING			
Fertilizer NPK	-	100,000	-
Labour for Fertilizer application	-	50,000	-
Manure application	120,000	-	-
Spray pump	80,000	-	-
Chemical (2 litres @ 15,000)	72,000	-	30,000
Labour for spraying	144,000	-	12,500
Jerricans (3 @ 3000)	9,000	-	-
Harvesting & Post-harvest handling			
Gunny bags, Turpuline & winnowing baskets	120,000	180,000	100,000
Labour (2 workers)	240,000	150,000	250,000
Drying	19,200	45,000	40,000
Threshing & winnowing	36,000	60,000	37,500
PACKAGING			
Storage chemical	-	-	25,000
Labour for sorting, packaging and storage	24,000	10,000	-
EXPENDITURE GRAND TOTAL (USHS PER HECTARE)	1,976,400	1,560,000	1,280,000
INCOME	3,000,000	3,000,000	3,000,000
NET PROFIT (USHS PER HECTARE)	1,023,600	1,440,000	1,720,000



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