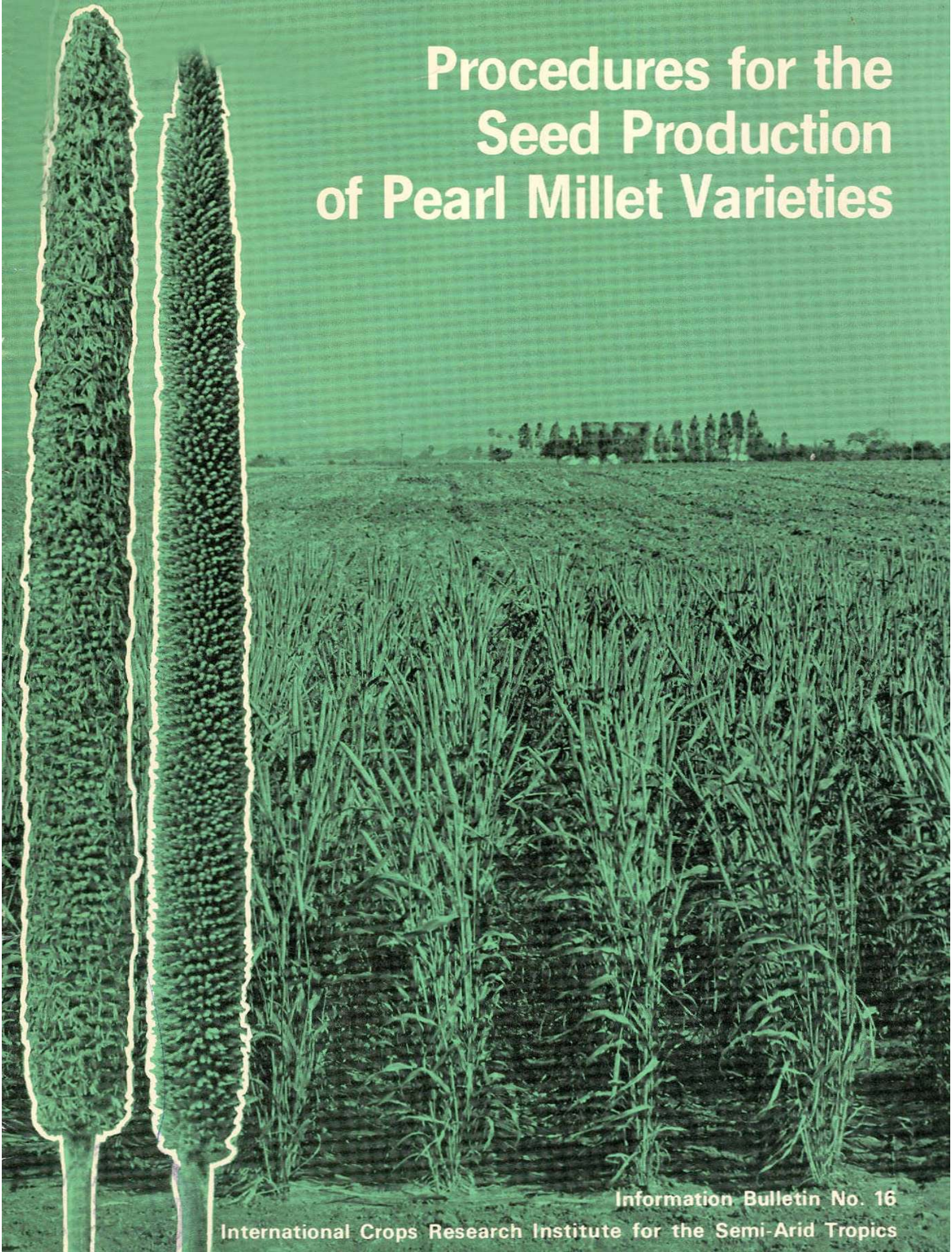
# Procedures for the Seed Production of Pearl Millet Varieties



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## Abstract

Andrews, D.J. and Harinarayana, G. 1984. *Procedures for the seed production of pearl millet varieties.* Information Bulletin No. 16. Patancheru, A.P., India: International Crops Research Institute for the Semi-Arid Tropics,

This is a guide to the techniques required to produce pure and vigorous seed from varieties of this cross-pollinated crop. Multiplication rates, through sequential breeder, foundation, and certified seed stages, are high: 3 kg of seed are adequate for sowing 1 ha, subsequently producing 1 tonne of clean seed. Nucleus seed plots (stage 0), sown for regeneration once every 4 years, should be effectively isolated. They should be between 0,1 and 0.2 ha in size, and contain at least 3000 plants. Plots of breeder seed (stage 1) should similarly be well isolated, and rigorously inspected and rogued, and not more than 1% of off-types should be permitted at final inspection. Plot sizes are normally between 0.1 and 0.5 ha, according to how much certified seed is required, using a conservative multiplication factor of X200. At the end of the foundation seed stage (stage 2), through protective perimeter planting, inspection, and rogueing, off-types should be less than 2%. At the final certified seed stage (3), the permitted level of off-types is 5%. Six points of guidance are given for extension staff to pass on to farmers who (as may be expected) attempt to multiply their own improved seed.

## Résumé

Andrews, D.J. et Harinarayana, G. 1984. (*Techniques de production des semences des variétés de petit mil.*) Procedures for the seed production of pearl millet varieties. Information Bulletin No. 16. Patancheru, A.P., India: International Crops Research Institute for the Semi-Arid Tropics.

Ce bulletin d'information est destiné à toutes personnes intéressées aux techniques de production des semences des variétés de cette espèce à pollinisation croisée, afin d'en obtenir des semences pures et vigoureuses. Les taux de multiplication sont très élevés au cours des trois stades de production : semences de sélection, semences de base, semences certifiées; il suffit de semer 3 kg de graines sur 1 ha pour obtenir 1 tonne de semences épurées. Les champs semenciers servant à renouveler le matériel de départ (stade 0) tous les 4 ans doivent être bien isolés, d'une superficie de 0,1 à 0,2 ha, portant au moins 3000 plants. Pour les semences de sélection (stade 1) les champs sont également bien isolés, le contrôle et l'enlèvement des plants non conformes y sont rigoureux; l'on n'admet que 1% de hors-types à l'inspection finale. La dimension des champs semenciers varie normalement entre 0,1 et 0,5 ha, en fonction de la quantité de semences certifiées requise, en employant un facteur de multiplication prudent de × 200. Au stade des semences de base (stade 2), la culture est protégée par des lignes de bordure et soumise à un contrôle et une épuration afin de maintenir la proportion de hors-types en dessous de 2%. Enfin, au stade des semences certifiées (stade 3), le niveau de hors-types admis est de 5%. Six recommandations sont proposées aux vulgarisateurs; ces derniers les communiqueront aux agriculteurs qui désirent multiplier eux-mêmes leurs semences.

*Cover:* A field of pearl millet planted for seed production with, inset, heads at the female-receptive stage (right) and the male-fertile stage (left).

# Procedures for the Seed Production of Pearl Millet Varieties

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# Contents




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# Preamble

Seed production procedures are well established for varieties in self- pollinated crops such as wheat and groundnuts, and for parents of hybrids in both self-pollinated and cross-pollinated crops such as sorghum and maize. All these breeding products are inbred lines in which there is maximum uniformity, and it is easy to identify off-types. The situation is different for varieties of cross-pollinated crops such as pearl millet, where a variety is a narrow-based breeding population exhibiting a range of variability, which also, during seed multiplication, needs to be protected against contamination by pollen of external origin.

One may ask why is there a need to breed varieties in pearl millet and, particularly, for variability within them? The principal reasons lie in the varied history of grain hybrids in pearl millet resulting from their short-lived resistance to downy mildew, their high susceptibility to ergot, and the cost of multiplication. The visible variability in pearl millet varieties is a consequence of the range of genetic variability for many useful traits, including variability for resistance to downy mildew that is the key to stability of resistance. This range of variability for resistance is very difficult to breed into hybrid parental lines but can be easily carried in breeding populations. Additionally, the variability in flowering in varieties provides normal protection against ergot infection, due to early and continuous pollen shedding. It has proved possible through breeding to raise the yield of varieties in pearl millet to the level where they are competitive with hybrids. It is therefore necessary to develop methods of seed multiplication of varieties that take into account their variability and cross-pollinating characteristics and capitalize on the very high multiplication rate obtainable. It is the aim of this information bulletin to detail these procedures.

# Introduction

Procedures for the maintenance and seed production of pearl millet varieties* vary slightly with the stage of multiplication—reflecting the principle that extra care is needed to maintain genetic purity at the early stages, and that there should *always* be an onward flow from stage to stage. Only nucleus seed, which is used for planting breeder seed plots, should regenerate itself, and then only under rigorously controlled conditions.

This bulletin concentrates on aspects of varietal purity when variety (not hybrid) seed is being produced. It assumes that adequate precautions are taken against physical admixtures either during planting (e. g., seed carry-over in machinery or volunteer seed in the soil) or during harvest and storage (in machinery or containers).

Pearl millet *(Pennisetum americanum* [L] Leeke) is a cross-pollinated crop. In comparison with maize, however, a field of pearl millet is more easily contaminated by outside pollen because of the species' protogyny (that is, the emerging heads become female-receptive before they become male-fertile). Therefore, during the 1 st or 2nd day of flowering a field of pearl millet is vulnerable to any external wind-borne pollen because little is being produced within the field. In maize, however, tassels normally shed pollen before the silks emerge.

While the need for good isolation during multiplication is recognized, permissible levels of off-types in varieties of cross-pollinated crops such as pearl millet (Fig. 1) can be higher than in varieties of self-pollinated crops or in hybrid parent lines. This is because (a) cross-pollinated crop varieties have a higher "buffering" capacity for off-type effects (a natural consequence of their variety population structure), and (b) if good isolation has been main-

*The term variety, for a cross-pollinating crop, means a self-reproducing population of plants which, although not genetically identical, exhibit unique, recognizable, and stable associations of characteristics. In pearl millet varieties include: landrace varieties, synthetic varieties made from inbred parents, varieties resulting from long-term mass selection, and experimental varieties made from elite progenies identified during the operation of a recurrent selection program.

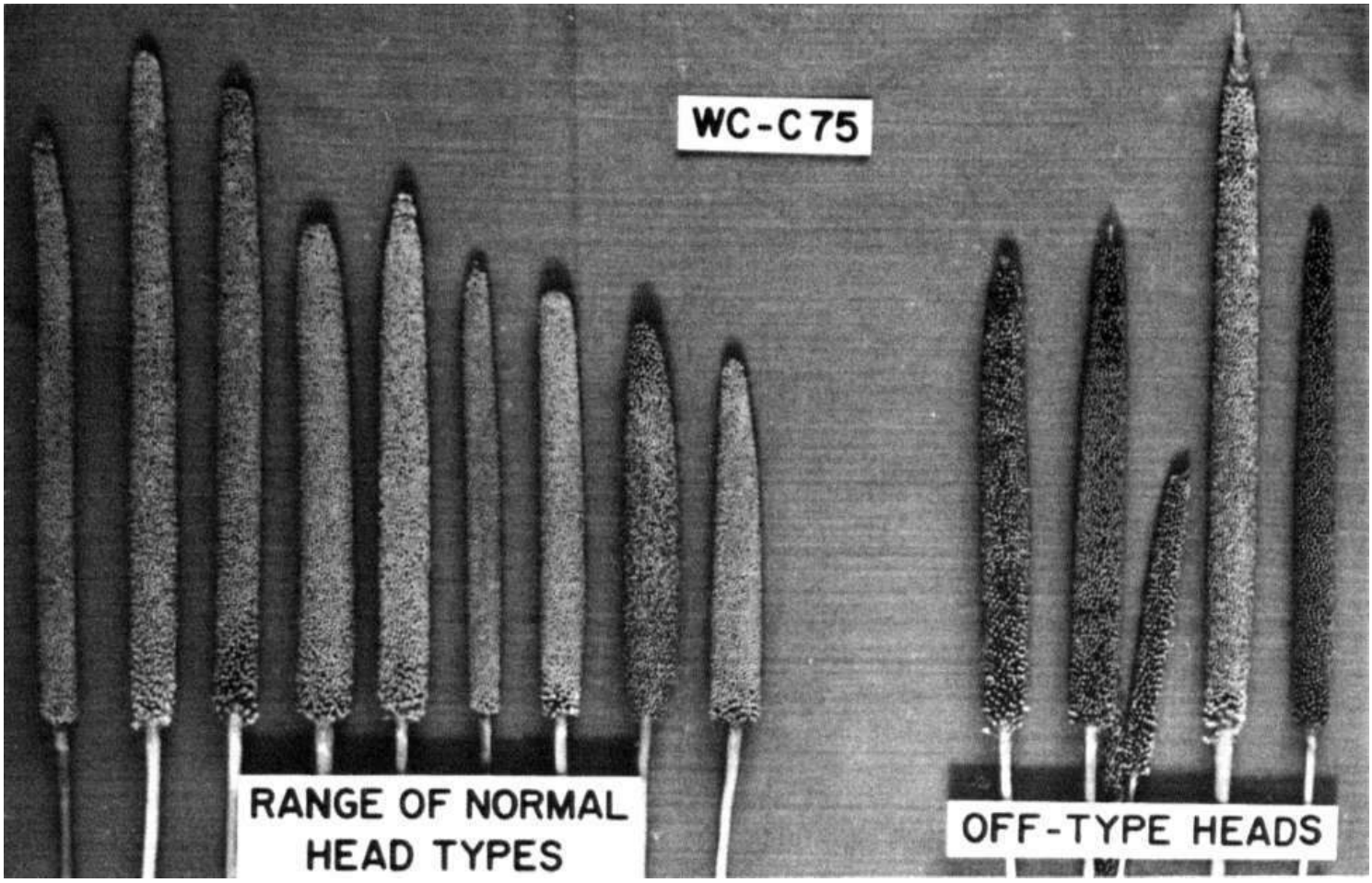


*Figure 1. The range of variability to be expected in a pearl millet variety (WC-C75), with examples of off-type heads.*

tained, most of the observed "off-types" will have arisen through recombination of genes already present and not from the introduction of alien genes or mutations.

Multiplication rates in pearl millet are high, particularly with varieties. Three kg of seed are more than sufficient to sow 1 ha. This should produce at least 1000 kg of clean seed even at a moderate level of soil fertility. Thus three stages of multiplication (Breeder-Foundation—Certified) are quite sufficient.

## Nucleus seed*

Nucleus seed maintained by the breeder is the fundamental stock from which all else derives and should be the *only* stock that regenerates itself. However, it should not be regenerated every year. Once in 4 years is recommended (see Fig. 2), when between 50 and 100 kg of seed should be produced. The produce of the nucleus seed plot should be thoroughly dried, treated against insect pests, and divided into six lots of 5-10 kg each, to be kept in hermetically sealed containers in a cool store, if available. Lots 1,2,3, and 4 are used to plant the breeder seed plots for the next 4 years; lot 5 is used to plant the next nucleus seed plot 4 years hence, and lot 6 is a backup or insurance lot that should be kept in a different building from the other lots.

Nucleus seed plots should be grown in extremely good isolation at least 2 km from any other plot of pearl millet, wild pearl millets, or elephant grass in the off-season, when crop growth and seed quality will be good. The plot

*This type of seed is not subject to certification but, since it is the basic stock, it requires special attention,

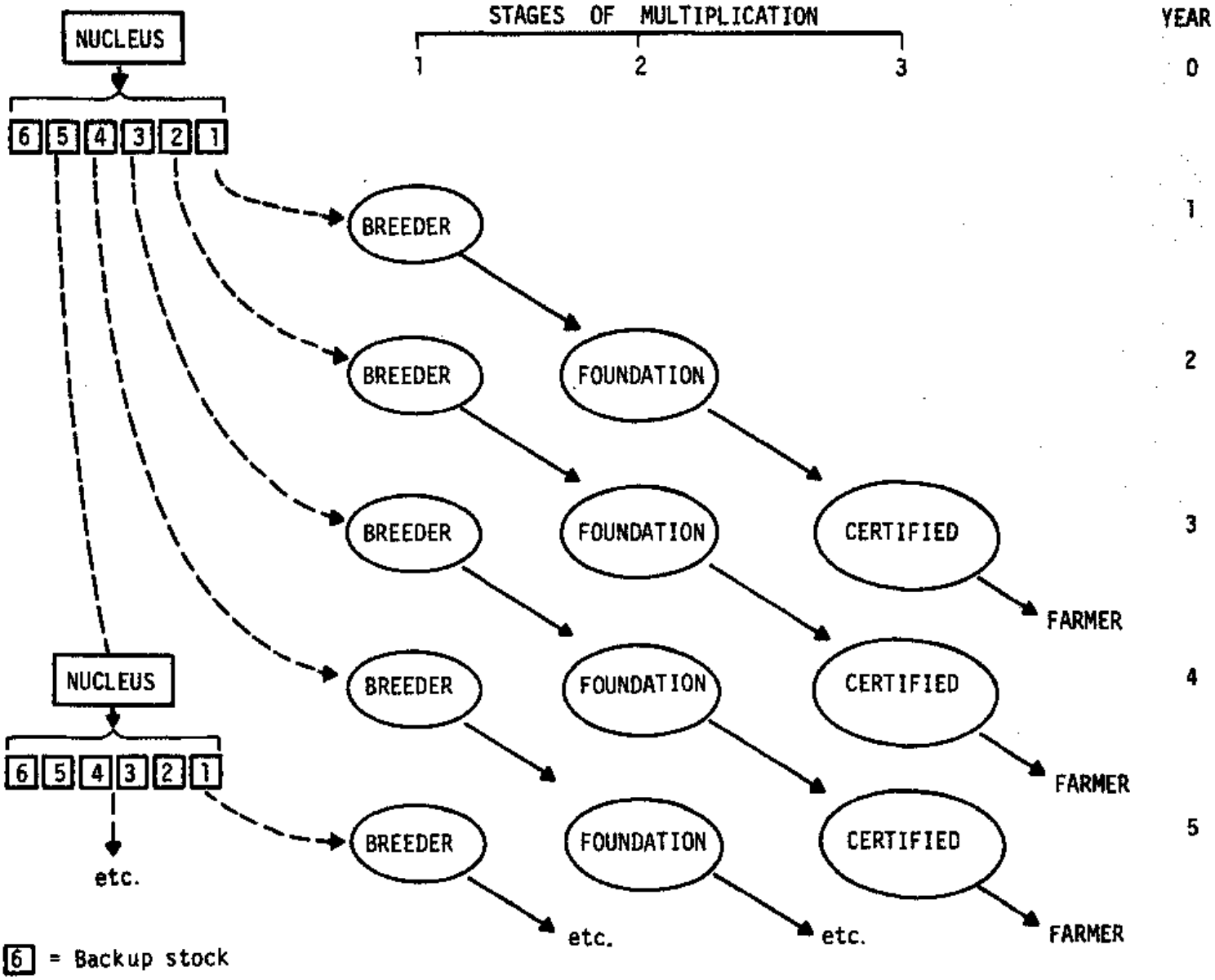


*Figure 2. Flow diagram of a three-stage seed production scheme for pearl millet varieties.*

should be thinned at an early stage to evenly-spaced single plants (or hill-planted and thinned to single plants), using only one third of the normal commercial plant population so that individual plant expression is maximized. Several inspections prior to flowering are recommended, to remove by uprooting (rogueing) any off-type plants. During flowering daily inspections are needed to identify and remove *all* plants suspected of being not true to type before they shed pollen. However, a final rogueing should be conducted in the standing crop before harvest to eliminate remaining off-types, if any. To ensure that variety norms do not change because too few plants have been grown, nucleus seed plots should not be less than about 0.1 ha, containing at least 3000 plants, and not more than about 0,2 ha because, in plots of large size, it is difficult to scrutinize all plants when daily inspections are required.

## Breeder seed

These plots should also be grown at less than the normal plant population, in extremely good genetic isolation (more than 1 km from other pearl millet plots) in the off-season (Fig. 3) then thinned to spaced single plants and rogued

*Figure 3. An example of a breeder seed plot, being grown in off-season isolation. The pearl millet variety is ICMS 7703.*

daily during flowering. Good rogueing at this stage reduces the need to do further rogueing in later stages. Not more than 1% of genetic off-types should be permitted at final inspection. The plot size can be 0.1 -0.5 ha, according to how much seed is required at the certified seed production stage, assuming a multiplication factor of x200. For example:

| *Breeder* → | *Foundation* → | *Certified* |
|---|---|---|
| 0.1 ha = 100 kg | 30 ha = 30 tonnes | 10,000 ha - 10,000 tonnes |

## Foundation seed

Use only certified breeder seed to plant these plots. These should be sown early on good uniform land at least 1 km away from the nearest pearl millet and preferably more from any pearl millet in the direction of the prevailing wind. With the same seed first plant a belt 4 m wide around the perimeter of the plot 4-7 days before planting the center. The purpose of the perimeter planting (from which the seed will be harvested separately and sold as grain) is to provide pollen by the time the plants in the

center begin to flower. This provides protection, based on dilution, against incoming wind-borne alien pollen. Before flowering, search for and destroy any volunteer pearl millet plants on field borders and ditches, and in nearby cropland. Rogue obvious off-types before flowering, to meet foundation seed standards. Varietal off-types should be less than 2% at final inspection.

## Certified seed

Use only approved foundation seed and sow large contiguous blocks, if possible in areas where other pearl millet plots will not be planted; but there should be a gap of at least 400 m from other millet. The crop will, for instance, grow very well in sloping light Vertisols where sorghum is normally the principal cereal crop. Alternatively, ensure that pearl millet farmers in the vicinity of the certified seed production plots are all given—and agree to grow—the same variety as that being multiplied. Rogue if possible, inspect (making sure that varietal off-types do not exceed 5% at the final inspection), certify, and bag (see Fig. 4).

*Figure 4. A tamper-proof pack of certified seed being used for sowing by traditional methods.*

## Postharvest procedures for certified seed

After plots that have passed certified seed inspection, routine precautions should be continued to protect the purity of the seed and to prevent adulteration, so that farmers may receive seed of guaranteed quality. Precautions should include harvest supervision, crop-drying, seed treatment, storage under licence, sealed bagging, and labeling.

## Seed multiplication by farmers

With pearl millet varieties it is possible for farmers to produce their own seed from a crop grown directly from certified seed. Though there may be irregularities when farmers multiply their own seeds, multiplication by them helps to promote the wider use of high-yielding varieties and, because many farmers will multiply their own seed anyway, advice should be given (as below) to make the seed derived from farmer multiplication as pure and vigorous as possible.

1. Where farmers practice irrigation, a small seed plot of pearl millet can be grown in isolation in the off-season. (Allow at least 6 weeks between harvest and planting the next crop to avoid any normal seed dormancy effects.) If the seed is to be produced in the normal crop season, very early plant-

ing is desirable, in fields well removed from other pearl millet fields (for isolation). In either case the fields used should not have had pearl millet as the previous crop.

2. Select heads for seed from *standing plants* in the field, just before general harvest-time.

3. Collect heads for seed only from the middle of the field, at least 10 m from the outside. (This does not apply to small off-season isolated irrigated plots.)

4. Choose heads with clean, well-formed grain from typical *average* plants. Do not choose early, late, extra tall, or diseased plants.

5. Choose not less than 500 heads, dry them thoroughly, and thresh them in a specially cleaned place (to avoid contamination with other pearl millet seed). Treat with insecticide and store in sealed containers such as jars or tins, with labels both inside and outside.

6. It is *not advisable* for farmers to grow their own seed more than once. Farmers should buy and plant 1 or 2 kg of new certified seed every year, so that they always have a plot of pure crop from which to generate their own seed by the procedures described above.

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