MAITENANCE BREEDING OF PASTURE GRASS VARIETIES

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ABSTRACT

Most fodder grass species are cross-pollinators. The majority of existing varieties is a result of mass selections for certain characters. A genetic shift can easily take place in such a population if seed is produced under climatic conditions different from those in the area of origin or if the selection pressure is remarkably different from that under which the variety has been developed. Seed production of new breeder's seed should therefore, be carried out in the area of origin, in isolation from other material of the same species, and under a selection pressure which favours the genes controlling the characteristics typical for the variety. Synthetic varieties based on a limited number of selected clones have a more restricted genetic variability but genetic shift can nevertheless, take place also in these varieties. New basic seed based on the original basic clone should therefore, be produced in the area of origin and the seed multiplication be carried on inside that area until genetic equilibrium is reached. Varieties of fodder grasses with apomictic seed formation are genetically very stable. New breeder's seed should here be produced on seed from the original apomictic clone planted out as spaced plants. All aberrant plants should be removed before seed harvest. In order to avoid the very laborious work involved in the maintenance of these types of varieties, it is recommended that sufficient basic seed of good quality be put in long time storage and that seed from this lot is repeatedly drawn and used for the start of new series of multiplication. A method has to be developed to maintain vegetative materials in tissue form and not in live nurseries.

INTRODUCTION

In the discussion on maintenance breeding of crops like cross- pollinated pasture grasses it is necessary to clarify the meaning of this expression and what the objective of the efforts involved in this activity should be. The expression "Maintenance" normally means a preservation of the existing situation while "Beeding" mostly includes genetical improvement. In many countries maintenance breeding of cross-pollinating species has often meant the maintaining of a specific type marketed under a variety name and at the same time a continuous improvement of characters like yield capacity, persistency, drought tolerance, pest and disease resistance. With the introduction of plant breeder's rights and the requirements connected with that on distinctness, uniformity and stability of varieties such a continuous improvement was not in accordance with the concept of variety. Under such conditions "maintenance breeding" must be restricted to the action which has to be under taken by the breeder to maintain a variety as constant as possible by repeated production of new breeder's seed with, as far as possible, the same genetical composition as the original variety. This paper will deal with maintenance breeding in this latter sense.

In the same way as varieties of all other crops, also grass varieties will deteriorate during the process of seed multiplication, and unless there is a continuous flow of new pure seed kept moving into commercial channels, the materials which reach the farmer will soon be very different from the variety developed in the plant breeder's nursery. A deterioration caused by mechanical reasons can be minimized by careful handling in the filed and during the process o harvesting, drying , seed cleaning , bagging, and distribution, but can never be completely excluded.

There is, however, also a genetical deterioration caused by changes in he gene frequency inside the population. These changes might be caused by mutations inter- crossing or selection. This genetical shift is different in different varieties because of their genetical composition and their mode of reproduction, and is under certain conditions unavoidable. The speed of this genetic shift can be increased by changes in the environmental conditions. The general shift is more pronounced in cross-pollinators than in self-pollinators. Varieties of self –pollinating species should theoretically consist of one pure line or a mixture of closely related pure lines and such varieties are very stable over the generations and are very little influenced by differences in environmental conditions. A variety of a cross-pollinating species can never possess the same degree of stability. Most of our commonly grown grasses are cross –pollinators and

the maintenance of these grass varieties will, to a high degree, depend on the behavior characteristic for a cross –pollinating population.

A variety of this type of species is composed of a large number of highly heterozygote plants resulting in a considerable genetical variation inside the variety. The reshuffling of the genetical substance for each shift from one generation to another makes that new gene combinations created over and over again. That it is all justified to use the term variety for such a sub-population depends on whether there is certain regularity also in the behavior of a genetically variable material. The gene frequency in a population will remain unchanged as long as there is a free mating among the individuals, no new genes are introduced by inter-crossing from outside, and the selection pressure is constant. That means that a variety of a cross –pollinating species remains unchanged from generation to generation as long as it is grown under the same environment conditions.

Characteristics of Grass varieties.

Contrary to the majority of our common field crops, most fodder grasses and legumes are grown for their vegetative parts. Further, they are perennials and should be harvested several times during each vegetation period. On the other hand, seed production is of less importance for the use of them as fodder. In the breeding of new varieties of these species, the main emphasis therefore is given to the improvement of such characteristics as increased leaf production, rapid regrowth, and resistance to repeated defoliation, increased persistence depending on drought and disease resistance, while characters related to seed production are more or less neglected(Gooster,1981). Those for a fodder grass variety typical characteristics are maintained in a natural way if seed production is carried out in those fields which normally are used for fodder production .If for instance a field normally used for grazing is fenced off and allowed to develop straw and seed, this seed is produced from plants grown under a selection pressure favourable for those characteristics which are desirable in a pasture grass variety.

Commercials seed production is, however, not carried out in that way. Normally it is done is areas with climatic conditions favourable for good seed production and under a management which favours high seed yield. This type of seed production puts the material under a selection pressure favouring entirely different characters than those for which the variety has been bred. Already a few generations of such seed production might cause a considerable change in the gene frequency inside the population, resulting in a remarkable genetic shift in a mostly not desirable direction. That is for instance, a case with grass varieties developed for conditions in high altitude areas adapted to a lot of rains like Kitale when they are taken to drought areas like Baringo for seed production and grown there for some generations, they will produce seed with very poor Pure Germinating Seed (PGS). Because of this, their productivity in the later harvest years will decrease. In order to be able to produce seed on a reasonable price, the number of generations from breeder's seed to commercial seed must be kept as low as possible and new basic seed must continuously be produced in the area of origin.

Maintenance of Cross- pollinating Grass Varieties.

The methods to use in maintaining the varieties of cross-pollinating grass species will depend on how the varieties have been developed. Most grass varieties are population varieties, developed through mass selection for certain characteristics such as disease resistance, earliness, general type, resistance to certain management stress. Such varieties will, after some generations after the final selection, reach a genetical equilibrium and will be stable with regard to their important characteristics as long as they are grown under the same climatic conditions and a constant selection pressure. If, however, the seed production is carried out under favourable cultivation conditions and the seed is harvested in the first harvest year, the variety might easily partially lose such specific characteristics as persistence, or resistance to hard management stress. New breeder's seed of varieties must be produced under such conditions which favour propagation of genotypes with desirable characteristics. Therefore, breeder's seed of all varieties should be produced in there area of origin. Similarly, from our specifically drought – resistance varieties should survive two or three dry periods before seed is harvested. A variety adapted t o hard grazing should be grazed for one or two seasons before it is allowed to go into seed. When these plots on which the breeder's seed is to be produced is allowed t develop straw and seed, care should be taken to remove all other grass of the same species in the neighborhood in order to avoid all inter-crossing from other varieties.

Maintenance of synthetic Varieties.

Synthetic grass varieties exist based on a limited number or selected clones. The genetic variation inside these varieties is normally much less than in the ordinary population varieties, especially if the number of basic clones is low. Generic shift can nevertheless take place also in these varieties if seed is produced under climatic conditions very different from those under which it has been developed. If seed production is started from the basic plants, genetic equilibrium will be reached after a few generations of multiplications. The level of this equilibrium might be different depending on the climatic conditions under which the multiplication is carried out. Basic seed production based on the original clones should therefore be grown in the area of origin. According to the seed regulations in certain countries basic material of imported varieties must be keep inside the country and be used for production of new basic seed there is however, no guarantee that seed developed in this way has exactly the same characteristics as demonstrated in the original variety and with seed imported directly from area of origin with other climatic conditions.

It is quite clear that the efficient and reliable production of new breeder's seed of these cross-pollinating varieties requires a good knowledge of the variety and its characteristics (Kivuva, 2004). It is therefore most desirable that h basic seed production is handled by the breeder or after very strict instructions from him. One must keep in mind that if the basic for such a variety has deteriorated and no original basic is available any more, it is almost impossible to completely restore the variety. In the same way, if one or more of the basic clones of a synthetic variety have died, new clones might be included and the general type of the variety be produced but there will be a difference in the genetical composition compared with the original variety.

Maintenance of Apomictic Varieties

A number of grass species used for fodder purposes have apomictic seed formation. That is, for instance, the case with certain species of the genus Cenchrius, Panium, Paspalum, Pennisetum and Poa. If the apomixi is complete, varieties of these species are genetically absolutely stable and any deterioration of such varieties is caused by intermixing of other verities in one way or another. There will be no genetical shift due to selection caused by varying climatic conditions or different management. Production of breeder's seed of these varieties is simple. Seed from the original clone or from basic seed multiplication is put out as spaced plants making it possible to observe any aberrating plants. These should be removed before the seed harvest and the rest be used for further multiplication. In some case, the apomixi is not complete but a certain percentage of the seed is produced in a sexual way resulting in a number of aberrating plants in the next generations. If this is the case, seed from basic plants has to be planted as spaced plants and all aberrating plants should be removed before seed harvest. As mostly plants obtained after sexual seed formation are weaker than the apomictic ones, next generations should be sown in close sward. Under these conditions, the sexually formed plants will normally have very little chances to develop and produce any seed. In such partially sexual varieties, however, the need for new basic seed production is much more urgent than in varieties with complete apomixi.

Maintenance of Vegetatively propagated Varieties

A number of grass species used for fodder purposes do not form seed and have to be maintained in vegetative form. That is, for instance, the case with certain species of the genus Pennisetum purpureum (Napier grass), Setaria splendida (Giant setaria), Tripsacum laxum (Guatemala grass), Panicum sp. (Giant panicum). Napier grass is, however, a cross-pollinating grass when it flowers and care must be taken to isolate the different clones or they should not be allowed to flower (Van Gastel 1978). Most of these

Vegetative grasses are propagated by cuttings or splits or rhizomes from the mother plants and this characteristic makes them more stable genetically over long periods of time. However, the clones have to be planted in live nurseries; this is laborious and makes it expensive in terms of labour and climate change

For, instance Napier grass is now prone to attack by Napier stunt and smut disease due to climate change and this is a looming danger in live nurseries.

Use of long Time Storage.

All production of new breeder's seed put considerable work-load on the breeder and he has to spend a considerable part of time on this work instead of the production of new varieties. The breeder's efficiency should therefore increase if a method could be developed by which the maintenance breeding of these varieties could be diminished or excluded. One method which has been used and is becoming more and more common

is to store a sufficient amount of basic seed with good quality under such conditions and it keeps its germination power for a very long time. That means under very dry conditions and low temperatures in airtight containers. Small seed lots of this seed will from time to time be taken and be used as basis for new multiplication. If, for instance, 100 kg are stored in this way, 20kg can be taken out every fifth year in order to start new multiplication series and this original seed lot will under such circumstances be sufficient as a basis for new basic seed production for a period of 20 years which in most cases is the life length of a variety. This method is the only one which can guarantee absolute stability in cross-pollinating population varieties. However, grasses are small seeded and care must be taken to make sure that the cold storage does not have frequent break down or electrical black outs.

CERTIFICATION

A certification authority in Kenya (KEPHIS) Kenya Plant Health Inspectorate service ensures that the set standards are observed. Kenya is a registered member of ISTA (1979), International Seed Testing Association and plant inspectors follow the regulations laid down in their handbook. The isolation distances differ depending on whether the variety is cross or self pollinated. The original breeder of the cultivar is the official registered maintainer of the cultivar or an appointed agent, for instance, Kenya Seed Company for forages jointly signed a memorandum of understanding with Kenya Agricultural Research Institute. The growers can only be allowed to multiply basic seed or certified seed of a generation acceptable for further multiplication under strict observation by the certifying authority.

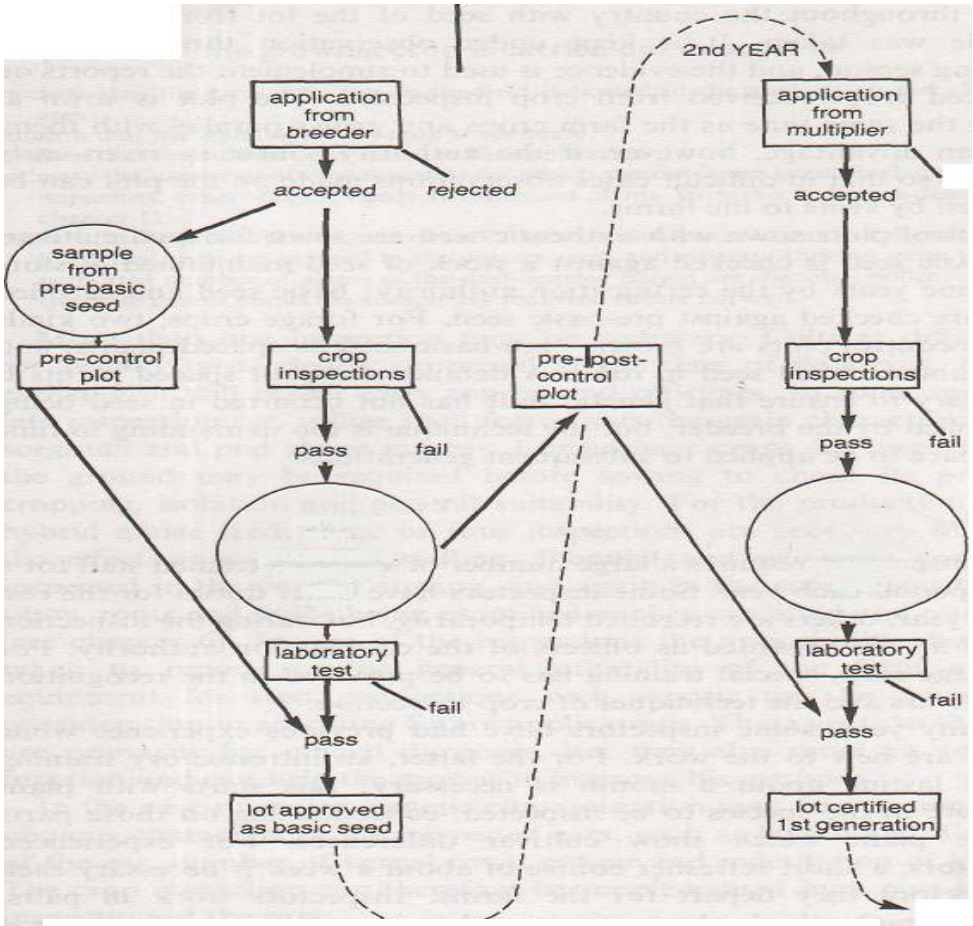
The process of seed production starts with Breeder seed ⇨ Pre-basic seed ⇨ Basic seed ⇨ Certified seed (generation 1-3) as in Figure.1 The crop must conform to the description and must be uniform and stable. A cultivar is released as variety after passing the test of National Performance Trial (N.P.T) and (D.U.S) Distinctness uniformity and stable trial for two to three years. Introduced cultivars must pass through quarantine at KEPHIS and entered into NPT and DUS test for at least two years before release. After the variety passes the field and laboratory tests at KEPHIS then white labels are issued to authorize sale to farmers.

CONSTRAINTS OF FORAGE PRODUCTION

1. Inadequate maintenance of germplasm, both vegetative and seed due to unavailability of funds and identification of a breeder as a maintainer.
2. Encroachment of diseases such as Napier stunt and Smut due to climate change.
3. Lack of interest by the mother countries especially in Africa to provide funds for breeding, therefore, no new cultivars are produced and released.
4. Frequent breakage of cold-storage, hence the loss of germplasm at a very high rate.

CONCLUSION.

Quality seed production is very important for the production of quality forages to feed livestock for increased milk and Beef. However, the maintenance of germplasm and the varieties need to be checked to avoid genetic shift of the varieties and loss of germplasm for future breeding. Funds need to be availed by the mother countries to enhance breeding of new varieties.



CERTIFICATION

Figure 1 : Certification procedures

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