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|  |  | **BREEDING CLONALLY PROPAGATED CROPS** |  |  |
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|  | *A clone* is a vegetatively propagated population of genetically identical plants. In asexually propagated species, the separate genotypes are propagated as clones. Clonal propagation may be practiced with species that produce seeds poorly or that produce seeds only under special conditions. Some crops normally propagated as clones are sugarcane (see Fig. 2.10), potato, sweet potato, cassava, sisal, taro, and some species of perennial grasses, such as bermuda-grass. Asexually propagated species have not normally been subjected to self-pollination and |  |
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|  | inbreeding, and individual plants are highly heterozygous, the heterozygosity being maintained through clonal propagation. With potatoes as an exception, most clonally propagated species are perennials. Aneuploid or polyploid chromosome genomes are maintained with clonal propagation, resulting in clones with chromosome numbers that differ from those recorded for the species. Breeding procedures for clonally propagated species may be grouped into: |  |
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|  |
|  | * Germplasm assembly and maintenance,
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|  | * Clonal selection of natural or induced variants, and
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|  | hybridization followed by selection and propagation of superior clones in the segregating population. |  |
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|  | ***GERMPLASM ASSEMBLY AND MAINTENANCE*** |  |
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|  | As with crops that reproduce sexually, the initial step in breeding asexually propagated species is to assemble a germplasm collection that is maintained as clones. The germplasm assembly may include clones selected from local populations if the species is native to the locality, introduced clones from genebanks or other breeders, commercially grown cultivars, or wild relatives introduced from their native habitat. The germplasm collection of clones constitutes the breeder's source nursery. Clones from the source nursery may be propagated and grown directly as cultivars, or the clones may be used as parents in a hybridization program. The germplasm collection is maintained as a collection of living plants in the field; this differs from maintaining a seed collection as in a sexually propagated species. Because vegetative propagation maintains the genotypes without change, except for mutation, large numbers of clones may be grown in the breeding nursery without isolation. In most countries it is mandatory that clones introduced from a foreign source first be grown in isolation to prevent the possible introduction of new species of insects or disease pathogens along with the clone. The hazard may be reduced by introduction of seeds instead of clones, if the species produces viable seeds. |  |
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|  | ***CLONAL SELECTION*** |  |
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|  | In a genetically mixed population of an asexually propagated species such as exists in nature, a superior clone may be isolated and propagated as a cultivar. In a mixed population, progress through clonal selection is limited to the isolation of the best genotype present. Genetic variability may arise in a clone by mutation producing bud sports, chimeras, or genetic mosaics. In species of ornamental plants, variants originating from natural or induced mutations are often utilized as the source of new clones. A high mutation rate has been observed in genotypes of sugarcane maintained through tissue culture techniques, with the mutant plants then propagated as clones. |  |
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|  | ***HYBRIDIZATION*** |  |
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|  | *Gene recombination occurs with sexual reproduction. In a crop species that is normally propagated asexually, sexual reproduction is necessary to create genetic variability through gene recombination*. By crossing clones with superior characters, source populations will be created that may be utilized for the selection of new clones as in self-pollinated crops. A typical procedure for developing a cultivar from an asexually propagated species, such as sugarcane, follows (Fig. 10. 11):

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|  |  | ***Crossing generation***: Cross Clone A × Clone B. |  |  |
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|  | ***1st season*:** Grow 10,000 F1 seedling plants. Select 1000 vigorous plants and propagate vegetatively. |  |
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|  | ***2nd and 3rd seasons*:** Grow 1000 clonal rows in 2nd season; select 100 superior clones. Grow 100 clones in 3rd season, preferably at two locations; select 10 superior clones. |  |
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|  | ***4th to 7th seasons*:** Grow selected clones in replicated field trials at several locations in comparison with standard cultivars or advanced breeding lines. |  |
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|  | ***8th to 10th seasons*:** Increase propagules of superior new clone and release as a new cultivar. |  |
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|  | Number of seedling plants and clones to grow are suggestive only and will vary with the species and resources of the breeding project |  |
|  | Due to the open-pollination, the parent clones will be heterozygous, segregation occurs in the F1 generation; each F1 plant is thus a potential source for a new clone and a new cultivar. Clones propagated from F1 plants are heterozygous and the heterozygosity of the clone is maintained through asexual propagation. If the breeder does not find a superior genotype in the F1 generation, the crosses are remade, or different crosses may be made. Self-pollination to produce an F2 is seldom practiced because self-pollination leads to a reduction in vigor and fertility. If a superior F1 plant is identified in the hybrid progeny, it is propagated vegetatively to establish a new clone which is evaluated in observation and replicated plot tests. |  |

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| Fig. 10.11.Hybridization procedure for a clonally propagated species. The seedlings grown in the first season are comparable to an F2 generation in a conventional hybridization procedure. The genotype of each seedling plant is maintained by vegetative propagation in the first and succeeding seasons. |

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