Better cultivars – more food

by A. Micke*

The experience of farmers throughout the world demonstrates the truth of the proverb "as the seed, so the harvest". Whatever is done to a crop after planting, what happens depends upon the inherent traits of the seed. Therefore, plant breeding has a high priority in all efforts to increase food production: providing the farmer with seeds that have the highest expectation of yield, of tolerance to adverse environments, of optimal utilization of land, water nutrients, and time, of quality for the processor and consumer, and last but not least an income for the farmer that will allow his family to live properly and give him an incentive to continue the struggle with nature that is essential for the survival of mankind.

Improvement of the characteristics of cultivars is first of all a matter of choice, of selection, as long as a rich natural variability allows the finding of characteristics that are desirable. It is possible to recombine desired characteristics by intercrossing. But if limits for further genetic improvement are being reached (and that will sooner or later be the case in all breeding programmes), the genetic variation to choose from has to be broadened by such means as mutagenic irradiation.

Mutagenesis has been known to scientists since about 1920, but has been applied in practical plant breeding only since about 1950. Plant breeders have shown increasing interest since the mid-60s, and one can now see economically relevant results of mutation breeding in a large number of different plant species: more than 300 improved cultivars of cereals, other grain crops, vegetables, forage crops, fruits, and industrial crops

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Lodging-resistant lines of durum wheat can be seen clearly in this photograph, surrounding damaged areas of crop grown from normal seed

Table 1. Mutant varieties of agricultural crop plants

Species	Name	Direct	Cross	Total
Arctium lappa	Burdock	3		3
Allium cepa	Onion	2		2
Arachis hypogaea	Groundnut	5	2	7
Avena sativa	Oat	4	4	8
Brassica sp.	Rape seed	5		5
Cajanus cajan	Pigeon pea	1		1
Capsicum annuum	Green pepper	3	1	4
Citrus sp.	Grapefruit	1		1
Cicer arietinum	Chickpea	2		2
Corchorus sp.	Jute	5	1	6
Eriobotrya japonica	Loquat	1		1
Cynodon sp.	Bermuda grass	1		1
Ficus carica	Fig	1		1
Glycine max	Soybean	8	1	9
Gossypium sp.	Cotton	5		5
Helianthus annuus	Sunflower	1		1
Hordeum vulgare	Barley	29	39	68
Lactuca sativa	Lettuce	2		2
Linum usitatissimum	Linseed	1	1	2
Lupinus sp.	Lupine	2	4	6
Lycopersicon esculentum	Tomato	4	1	5
Malus sp.	Apple	4		4
Mentha sp.	Mint	3		3
Nicotiana tabacum	Tobacco	1	4	5
Olea europaea	Olive	1		1
Ornithopus compressus	Serradella	1		1
Oryza sativa	Rice	44	24	68
Pennisetum sp.	Millet	1	1	2
Phaseolus vulgaris	Bean	5	5	10
Pisum sativum	Pea	6	2	8
Prunus armeniaca	Apricot	1		1
Prunus avium	Cherry	6	1	7
Prunus persicae	Peach	2		2
Punica granatum	Pomegranate	2		2
Ribes sp.	Currant	1		1
Ricinus communis	Castor bean	2	1	3
Saccharum officinarum	Sugar-cane	9		9
Secale cereale	Rye	3		3
Sericae lespedeza	Lespedeza	1	1	2
Sesamum orientale	Sesame	1		1
Sinapis alba	Mustard	1	2	3
Solanum tuberosum	Potato	1		1
Solanum khasianum		1		1
Trifolium incarnatum	Crimson clover	1		1
Trifolium subterraneum	Subterranean clover	1		1
Triticum aestivum	Bread wheat	24	6	30
Triticum turgidum	Durum wheat	7	8	15
Vigna radiata	Mungbean	3		3
Vigna angularis	Azuki bean	1		1
Zea mays	Maize	3	4	7
		223	113	336

(Table 1) and more than 250 of ornamentals (Table 2). Most of them represent induced mutants that were found suitable for cultivation as such, while others are derived from cross-breeding with induced mutants. The countries where successes have been achieved are listed in Table 3.

The desired characteristics that have been obtained by mutation breeding in agricultural crops are mainly of kinds that have not been favoured by natural selection in evolution, or derived in previous plant breeding efforts. These include characteristics such as lodging resistance at high fertilizer levels, short duration for adaptation to modern crop rotation systems, tolerance to altered day-length (permitting expansion of a crop north or south of its original environment), or resistance to soil-borne diseases.

Many mutants already released for use as cultivars in farmers' fields (and others) have subsequently been

Table 2. Ornamental mutant varieties

Abelia	1
Achimenes	11
Alstroemeria	15
Antirrhinum	4
Azalea	12
Begonia	21
Bougainvillea	6
Chrysanthemum	98
Dianthus	2
Dahlia	35
Euphorbia	1
Guzmania	1
Hibiscus	4
Lilium	2
Malus	1
Polyanthes	2
Portulaca	12
Rhododendron	1
Rosa	7
Streptocarpus	18
Tulipa	2
Total	256

Table 3. Numbers of mutant varieties in different countries

Algeria	1
Argentina	3
Australia	3
Austria	5
Bangladesh	6
Belgium	8
Burma	2
Canada	10
China	9
Czechoslovakia	16
Denmark	1
Egypt	1
Finland	6
France	11
German Democratic Republic	15
Germany, Federal Republic of	18
Greece	1
Hungary	3
India	88
Indonesia	1
Italy	9
Ivory Coast	1
Japan	33
Korea, Republic of	3
Netherlands	102
Norway	1
Pakistan	1
Philippines	3
Sweden	15
Thailand	2
UK	7
USA	42
USSR	36

utilized in cross-breeding programmes, in order to achieve further improvement by recombining desirable traits. Thus, mutation breeding has a continuing impact. Plant breeding in general is a never-ending activity, since although it may become more and more difficult there is always a need and scope for further improvements.

The Joint FAO/IAEA Division, during its 20 years of existence, has encouraged and supported research to advance the technology of mutation breeding. This has required the adjustment of established methods to suit the peculiarities of different plant species, and formulation of procedures for selecting desired mutants to meet a wide array of breeding objectives. Most recently, *in vitro* culture techniques have been added to the plant breeders' armoury.

Plant breeders in many countries have been advised and trained, and assistance has been given in the form of equipment and supplies. The Section has published since 1972 a Mutation Breeding Newsletter, which is distributed free of charge and has a readership of 4000 to 5000. Its objective is to keep plant breeders all over the world abreast of developments and achievements in this field, which is of such a high relevance to agricultural development. The Section has also produced a Manual on Mutation Breeding, published first in 1970 and now in its second edition, which has become a standard textbook. A wide variety of other publications, resulting from advisory group meetings or symposia, also serve as essential sources of reliable information.