27
PRESENT SITUATION CONCERNING THE INTRODUCTION OF PERENNIAL HABIT INTO MOST IMPORTANT ANNUAL CROPS

Alessandro Bozzini

Agenzia Nazionale per le Nuove Tecnologie, l'Energia e lo Sviluppo Economico Sostenibile (ENEA)
Email: alessandro.bozzini@libero.it

There are two main options available for developing perennial crops. The first is through the introduction of perennial traits from wild species into related domesticated crops by crossing or by transferring pertinent genes. The second is through the domestication of wild perennial species using a selection of available biodiversity or through the introduction of domestication characteristics from related domestic species. The first method seems to be the most rapid, while the second could be more difficult and time consuming.

PERENNIAL RICE

Perennial rice is currently the most advanced of the perennial cereal species, as some cultivated rice strains are already able (in humid tropical areas) to have regrowth after crop harvesting. In fact, humid tropical areas could be the first areas to adopt new perennial rice types. In temperate areas the most important limitations for perennial rice may be drought, cold resistance and longevity.

PERENNIAL WHEAT

A high number of progenies derived from crosses of hexaploid and tetraploid (*T. carthlicum*) wheats with several *Thinopyrum* species are available because of crosses made from transferring disease resistance into wheat species. At least a dozen selected perennial wheat lines (out of more than 250 crosses) have now been tested and analysed in international trials. In this material, the main characters to be improved are: shorter straw, earlier ripening, shorter spikes, larger grains, resistance to cold, higher production per hectare, potentiall a smaller number of chromosomes (now most lines are octoploid 2n=56) and chromosome number stability. In the future, some lines could be adopted, especially in polycultures and marginal areas and because of consistent production and cost savings. Some lines could also be useful for dual-purpose grain and forage production.

PERENNIAL RYE

Several selections derived from crosses with the perennial *Secale montanum* are available and adapted to acidic soils and mountain areas, where some rains last the entire year. Further selections should be developed, especially for improved bread making.

PERENNIAL SORGHUM

Several selections of perennial sorghum are now available which are derived from crosses of *S. halepense* (4x) with *S. propinquum* (2x). Some lines of *S. bicolor* are also examples in which regrowth is present. The breeding is looking for both 2n and 4n types. The main limitations are now: small seeds, cold resistance, and shorter straw. The realization of perennial sweet (sucrose) sorghums should also be a priority in order to have the production of seeds, sugar and of straw to be used for animal feed, production of methane or cellulose transformation into sugars. The resilience to drought is an important characteristic of perennial sorghum and its adoption in farming systems affected by climatic events should be further promoted.

PERENNIAL MAIZE

Given the increase in maize seed production obtained in the last 50-60 years, the realization of perennial maize types showing a decent production seems to require several more decades of research, in part because of the very large differences in morpho-physiological characteristics of the perennial related species.

PERENNIAL MILLET

At least two perennial species related to *Pennisetum* are available to transfer perenniality into pearl millet. At the moment there is very little information on breeding for perennial types. Further research and development is essential as perennial millet, sorghum and other drought tolerant crops are key for the food security and livelihood of millions of people in dryland agricultural systems.

PERENNIAL BARLEY

The utilization of *Hordeum bulbosum* for transferring the perennial habit into barley seems difficult because of *bulbosum* chromosome eliminations in F1 crosses. The utilization of other perennial *Hordeum* species should be further explored, especially in lines adapted to marginal areas (e.g. northern, cold climates), requiring short growing cycles.

PERENNIAL OATS

The most likely perennial species present in the *Avena* genus that could be used is the 4n *Avena macrostachya*, found in Algerian mountains and is well suited for areas that require short growubg cycles with limited water. At the moment no information is available concerning this objective.

OTHER SPECIES

Perennial species are also present in *Milium, Panicum, Echinocloa* etc. and related to cultivated ones, which could be used for the introduction of perenniality. Increased policy and research attention should be placed on the wide range of poorly explored and domesticated cereals in order to have the genetic base which allows for a shift towards more sustainable and flexible agricultural systems, enabling farmers to expand their farming options.

GRAIN LEGUMES

At the moment only *Cajanus cajan* is normally used as a perennial grain crop in India and Africa. However, related perennial species are present in *Cicer* (chickpea), *Glycine* (soybean), *Lathyrus, Lupinus, Vigna* etc. which could possibly be used. Grain legumes increase nitrogen availability in soil and are important sources of protein.

SUNFLOWER

There are several perennial *Helianthus* wild species in North America. The introduction of bulbs into *H. annuus* (sunflower) from *H. Maximiliani* (2x) and from *H. tuberosus* (4x) are ongoing, particularly in the United States, with interesting results.

OTHER OIL CROPS

In several annual oil producing species, such as *Carthamus tinctorius*, *Linum usitatissimum* (flax), *Sesamum indicum* (sesame), *Gossypium* (cotton) wild perennial species are present: *Carthamus lanatus, Linum perenne, Sesamum calycinum, Gossypium arboreum* (2x) or *G. barbadense* (4x) etc. that could be used for perenniality transfer.

FORAGE LEGUMES AND GRASSES

Several cultivated forage legume genera (e.g. *Lotus, Coronilla, Onobrychis, Vicia*) perennial related species which could be used to further develop perenniality.

CONCLUSIONS

The objective of introducing perennial traits into many domesticated crop species could interest many breeders working with the most useful species for the improvement of their performance and for saving production costs and labour. Permanent forage species are fundamentally important for improved crop-livestock systems. A wider adoption of diverse perennial forages needs to be further explored by researchers and supported by policy instruments to meet the increasing demand for livestock products and environmental sustainability.