Session 1
Plant breeding and fruit quality

key-speaker: **Dr. Damiano Avanzato**

FARMING AFFECTS PLANT GENETIC EROSION: POLICY ACTIONS TO PREVENT IT

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Abstract

According to FAO estimations, worldwide genetic erosion has diminished genetic diversity among cultivated plants by around 75%. The main reason is found in modern agricultural production primarily based on intensive models cultivation, utilizing genetically uniform material of domesticated species. These obtained a predominant role when man advanced from hunter and gatherer to farmer, selecting and "domesticating" the wild relatives of today's cultivated plants (Crop Wild Relatives, CWR). The CWR, acting as a genetic basin whenever a cultivated species needs to be improved, have to be protected in the same way as cultivated species are. A research conducted by the PGR Forum working group shows that CWRs account for 77% of all existing species in the Euro-Mediterranean area. This result underlines the potential vulnerability of our agricultural systems in the event of the vanishing of the genetic support provided by this particular plant genetic diversity. Also cultivated varieties are subject to genetic erosion. An analysis of a number of still lives collected in the Botanic Museum of the University of Florence showed that 116 different varieties of citrus, 10 of apricot, 26 of peach, 66 of cherry, 30 of fig, 53 of apple, 109 of pear, 75 of plum and 75 of grapevine were present in Tuscany at the beginning of the 18th century. Only 150 cultivars, however, were mentioned in a Tuscan newspaper article published at the beginning of the 19th century: over 400 fruit tree varieties have probably vanished within only a bit more than a hundred years of time. The genetic erosion affected also the accessions from historical gardens, theoretically protected sites, and several genotypes resulting lost. Nevertheless the historical sites such are the abandoned castles can become the places where to establish the synergy between history and plant genetic safeguard.

1. Introduction

All species, cereals as well as vegetables and fruits, are rich in examples teaching that even if a genetic character is not particularly appreciated in a certain historical or agricultural context, nonetheless it is important to save it for future generations (Avanzato and Kell, 2005). For example, with regard to fruit cultivation, orchards of the past were made of vigorous trees, later on dwarfing genetic character in the trees was searched in order to allow fruit harvesting without the help of ladders or mobile platforms. The classic example is the agronomic revolution in the world apple cultivation which was determined by the development of the wild species "dolcino" and "paradise" selected at East Malling (UK) as dwarfing rootstocks.
The basin where the Humans always found the domesticating accessions is the Crop Wild Relatives (CWRs). Many examples show the importance of the CWRs of it. The *Corylus colurna*, spread in Romania as well as in other countries (Bulgaria, Turkey, Georgia, etc) is a tree without economical relevance; its fruits are usually hate by the bears ("bear hazel" is the popular name in the Balkans and the Caucasus). However, *C. colurna* has an agronomic characteristic which is very important: it does not produce suckers, an aspect which might cause a re-arising of hazelnut cultivation, saving large amounts of production costs. Another example showing the importance of the CWRs are the few trees of *P. atlantica* and *P. terebinthus* carrying the monoecious genetic traits (Kafkas *et al*, 2001; Avanzato, 2003) that could be used for agronomic exploitation on pistachio (*P. vera*).

Despite the clear evidence of the importance of CWRs heritage, this patrimony of the Humanity is often damaged. According to FAO estimations data, worldwide genetic erosion has diminished genetic diversity among cultivated plants by around 75%. The main reason is found in modern agriculture based on intensive models utilizing genetically uniform material and spread everywhere.

2. Material and methods

Looking the nursery market offer, it can observe a wide number of seeds and varieties available for farming, as result of the dynamic work of the breeders. Very few are the past varieties survived, one for example is the plum Regina Claudia selected since the Roman time. The modern Humans philosophy "Use and throw away" is responsible of the loose of many varieties obtained by our Ancestors. How many old accessions are missed? Is not easy the answer to this question, but by some un-direct analysis can put in evidence how seriousness is the problem.
Fabio Ardito, chronicler of Pope Gregorio XIII's travels in 1579, describes one of the sections of Farnese Palace, near Rome, with the following words: "*In the garden, in addition to several fruit-bearing trees, there are beautiful cedars, placed where they are less likely to be offended by the cold wind from the North*." Nowadays, only few specimens of orange, chestnut and hazelnut have remained in this garden.
An analysis of a number of still-lives collected in the Botanic Museum of the University of Florence showed that 116 different varieties of citrus, 10 of apricot, 26 of peach, 66 of cherry, 30 of fig, 53 of apple, 109 of pear, 75 of plum and 75 of grapevine were spread in Tuscany at the beginning of the 18th century. In a Tuscan newspaper article published at the beginning of the 19th century, from the previous list, 150 cultivars only, were mentioned, that is to say that over 400 tree fruit varieties have probably vanished within only hundred years.
This phenomena was clearly evidenced by an investigation based on the exam of 122 nursery catalogues edited from 1897 to 2005 in Italy, inquiring apple, apricot, cherry, peach, pear, plum, and quince marketed varieties (Avanzato and Raparelli, 2005). The catalogues were grouped in three periods: the first one, leading from 1897 up to 1932, includes 33 catalogues; the second one, including the period between 1933 and 1966, comprises 43 catalogues, and the last group, from 1967 up to 2005, includes 46 catalogues. The criteria adopted to define the three periods took into account the fundamental national laws which promoted the evolution of Italian agriculture in past century. This policy started in 1933 and continued with the "Piano Verde" laws, expired in 1966 and other laws issued up the year 1990. These laws promoted a significant change in Italian agriculture, which moved from the old land-owner model to modern intensive farming management.

Levelled sloping lands reclaimed to crop cultivation affects genetic erosion of autochthons

3. Results and discussions

Table 1 and 2 shows two significant example of the planting evolution occurred both on coast as well as on hinterland areas during the period 1960-1990.

Table 1. - Evolution of crop surfaces from 1960 to 1990 in Agrigento (Coast area)

	1960		1970		1980		1990	
	Ha (000)	%	Ha (000)	%	Ha (000)	%	Ha (000)	%
For sowing	245	84	187	67	131	49	103	45
Trees	23	8	55	20	86	32	87	38
Meadows	23	8	22	8	20	8	10	4
Forestry	Not recorded		15	5	30	11	31	13

Table 2: - Evolution of crop surfaces from 1960 to 1990 in Caltanissetta (Hinterland)								
	1960		1970		1980		1990	
	Ha (000)	%	Ha (000)	%	Ha (000)	%	Ha (000)	%
For sowing	163	85	129	73	106	62	109	66
Trees	16	8	17	10	27	16	26	16
Meadows	12	6	8	5	10	6	7	4
Forestry	Not recorded		20	12	26	16	23	14

As result of this policy, a dynamic expansion and the re-conversion of fruit plantation initiated. Who was the catalyser of this re-conversion? Of course the nurseries, which started adapting their assortments of varieties with latest ones but, at the same time, this update policy determined the abandonment of several old fruit genotypes which in many cases were lost. The observed genetic erosion was quantified on the basis of the number of cultivars listed in the first period (1897-1932), which was considered as 100%. The survived cultivars recorded in the other two groups were calculated as relative percentages. The results shows that on the latest issued catalogues (1967-2005) 12% apricot (fig. 2) and pear (fig. 6) remains on the list of the offered varieties, while the rates of apple, peach, plum and cherry (figs 3, 4, 5 and 8) ranges between 20% and 22%. Almond and quince (figs 1 and 7) old varieties, two species practical abandoned, ranges 25 and 28%, respectively. These data testifies how strong was the impact of the agricultural modernization on the landscape changes.

To stop and to prevent the genetic erosion many actions at National, regional and local levels have been taking.

At National level, a successfully way to recovery many old fruit varieties was a project aimed at the monitoring of the historical gardens. In Italy, assuming that several of the old varieties might have survived in these sites, a national research programme was implemented to survey, recovery and valorise the survived accessions in Piemonte, Toscana, Emilia Romagna and Sicilia gardens. In Lazio region a three years research programme was developed (Avanzato, 2004), and the recovered accessions were propagated and kept in a fruit germplasm collection. Among the most interesting accessions identified, there is a cherry capable to survey on the tree after ripens which was detected in the garden of Castelgandolfo (Vatican's property) and a re-flowering orange, found in the gardens of Valvisiciolo Monastery. The spread of this orange might give promising incentives to orange growers, since one of the flowering cycles leads to maturation during summer, an un-usual period compared to the traditional harvest time. In another place (Ninfa's gardens), numerous *Malus* and *Prunus* were found (Table 3).

An international EU project, the PGR Forum *(European Crop Wild Relative Diversity Assessment and Conservation Forum),* joined 21 European countries, together with IUCN and IPGRI *(*Avanzato and Kell, 2005), for preparing future safeguard strategies. Italy contributed to PGR Forum through the classification of 4 750 species of CWR present on the national territory, which account for 21% of all existing CWR in the European and Mediterranean countries. The PGR Forum Working Group developed an on-line database on European and Mediterranean CWR that includes more than 23 000 species.

However, Italy is involved in main policy international actions aimed at the protection of the genetic heritage, such as the IUCN (International Union for the Conservation of Nature and Natural Resources aimed at the identification, documentation and safeguard of undomesticated biodiversity), the GEF (Global Environment Facility establish in 1991 with the aim to help developing countries to take actions targeted at the safeguard of the global environment), the Agenda 21 (UN programme ratified in 1992 in Rio de Janeiro for the global promotion of sustainable integration and development in order to achieve an efficient and equitable World economy), the CBD (Convention on Biological Diversity, ratified in 1992), the GPA (Global Plan of Action for the conservation and sustainable utilization of plant genetic resources held 1996), and the FAO International Treaty aimed at the conservation and sustainable use of plant genetic resources for food and agriculture and the fair and equitable sharing of benefits derived from their use, in harmony with the Convention on Biological Diversity, for sustainable agriculture and food security.

In 2004 the Italian Government ratified the FAO Treaty and entrusted the CRA - "Centro di Ricerca per la Frutticoltura" (CRA-CRF) of the coordination of the research activities of the Institutes for Agronomy, Citrus, Cereals, Fodder and Industrial crops, Flower, Fruit, Olive and Olive-oil, Viticulture, Vegetables, Tobacco, Sylviculture, Forestry, Zoology and Plant genetics resources. This leading activity is also strengthened by the establish of the National Centre of Fruit Germplasm (NCFG) at CRA-CRF in Rome, funded by the Agricultural Ministry, and targets to the rationalization and harmonization of the conservation of about 12 000 tree fruit accessions present throughout the different Italian institutions.

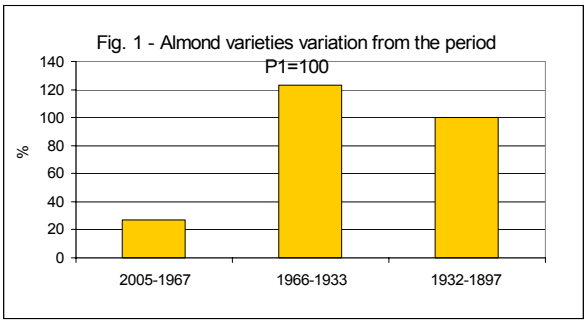
Fig. 1 - Almond varieties variation from the period P1=100
%
140
120
100
80
60
40
20
0
2005-1967
1966-1933
1932-1897

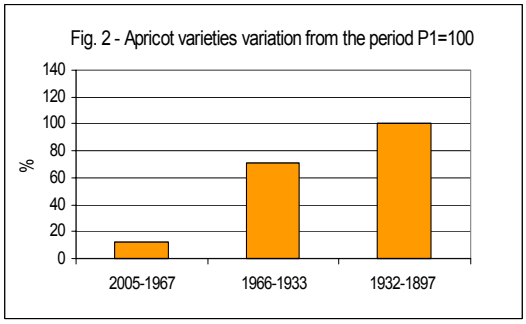
Fig. 2 - Apricot varieties variation from the period P1=100
%
140
120
100
80
60
40
20
0
2005-1967
1966-1933
1932-1897

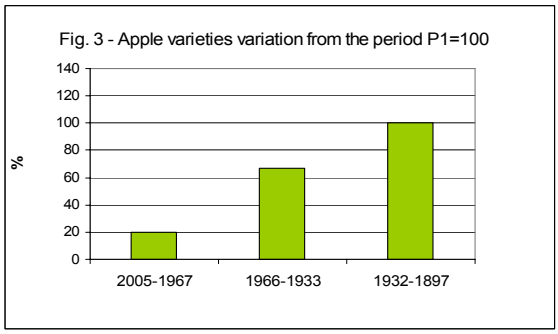
Fig. 3 - Apple varieties variation from the period P1=100
%
140
120
100
80
60
40
20
0
2005-1967
1966-1933
1932-1897

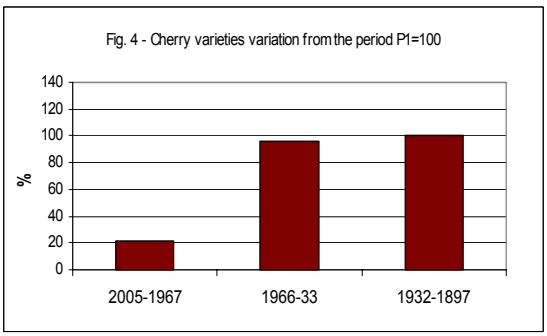
Fig. 4 - Cherry varieties variation from the period P1=100
%
140
120
100
80
60
40
20
0
2005-1967
1966-33
1932-1897

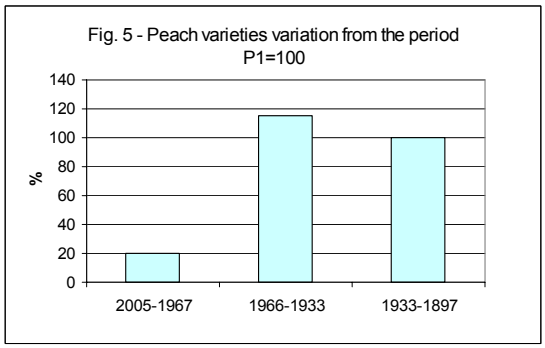
Fig. 5 - Peach varieties variation from the period P1=100
%
140
120
100
80
60
40
20
0
2005-1967
1966-1933
1933-1897

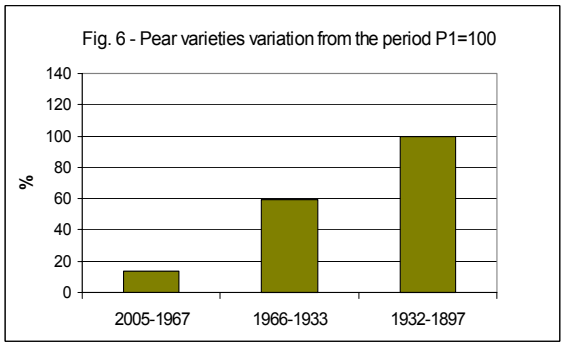
Fig. 6 - Pear varieties variation from the period P1=100
%
140
120
100
80
60
40
20
0
2005-1967
1966-1933
1932-1897

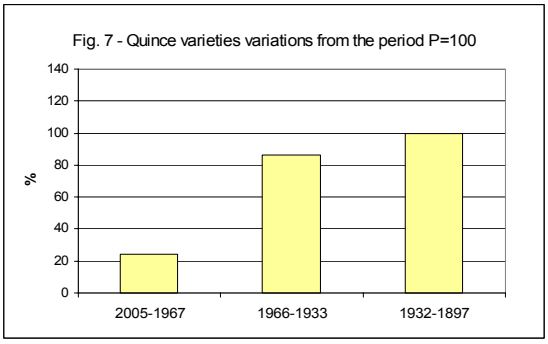
Fig. 7 - Quince varieties variations from the period P=100
%
140
120
100
80
60
40
20
0
2005-1967
1966-1933
1932-1897

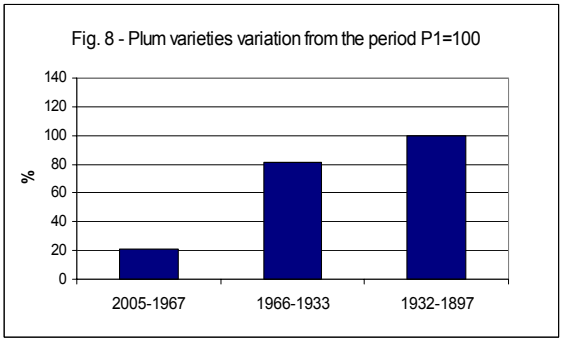
Fig. 8 - Plum varieties variation from the period P1=100
%
140
120
100
80
60
40
20
0
2005-1967
1966-1933
1932-1897

Table 3: Characteristics and uses of the *Malus* and *Prunus* recovered in Ninfa's Garden
M. baccata. Rootstock for apple, compatible with the cultivars Vered, Starking and Fuji. Pollinator of apple. Used in breeding programmes for the development of cold-resistant hybrid rootstocks as well as a source of genetic resistance to apple scab, *V. inaequalis.*
M. floribunda. Pollinator of apple. Used in breeding programmes as source of genetic resistance to *V. inaequalis* and *Podospharea leucotricha*.
M. hupehensis. Rootstock for apple: in China it is recommended for Geneva Early, Vista Bella and Jerseymac.
M. x micromalus. Rootstock for apple in soils of high salinity, calcareous or subject to stagnating water. Utilized in breeding programmes for the development of cold-resistant rootstocks. Fresh consumption.
M. Profusion. Pollinator of the apple cultivars Holsteiner Cox and Jonagold.
M. John Downie. Pollinator of the apple cultivars Elstar, Cox 's Orange Pippin and Jonagold.
P. padus. Rootstock for sweet cherry, utilized on heavy soils and in cold regions.
P. tenella. Breeding for cold resistance, dwarfing habitus, and not susceptibility to Sharka.
P. davidiana. Resistant to some nematodes, applied in programmes of interspecific hybridization
P. incisa. Serves for the development of interspecific dwarfing rootstocks...
P. x yedoensis. Utilized as dwarfing rootstock of sweet cherry or for the development of hybrid rootstocks, for example GM8.
P. x subhirtella. The variety "pendula" has a potential for being utilized in interspecific crosses, since the weeping character is genetically linked to the resistance towards *aphis*.
P. x blireana. Plum's rootstock.

The NCFG in Rome

The collections has not a "museum value", but is managed in a systematic and dynamic way comprising technical-scientific activities (collection, conservation, characterization and evaluation of the accessions) as well as economic and socio-cultural initiatives. For the realization of these prospectives, an area of 30 hectares is devoted in the green park of the old Appia Antica, in the southwest of Rome. Five years after the beginning of the activity, more than 6 000 accessions have already been planted in the fields of the Centre, a constantly growing number, which is intended to reach 12 000 within the next few years, also through safety duplicating accessions present in the different private and public collections.

4. Conclusions

The recovery of old varieties is not only a mere cultural issue but also a potential investment in niche markets. As a matter of fact, the current crisis of domestic markets is also due to uncontrolled globalization, which is one of the reasons for the standardization on the supply side. Old fruit cultivation, based on a natural diversification of varieties and perfectly linked to the territory, its customs and in line with the related ecosystems, would not have had to fear the impacts of globalization. Without forgetting the essential contributions to domestic fruit cultivation supplied by the breeding sector, a sort of recalling the old times through the recuperation of some of the most significant old varieties could be the first step to reverse the current trends both of fruit production and mentality of consumption. Despite the large investment and efforts made at national level, the safeguard of the plants heritage can be furthermore strengthened with additional initiatives. Some methodological approaches towards the practical implementation have already been initiated, at regional level, as for example "on farm" cultivation of certain varieties at risk of genetic erosion, carried out by "Caring Cultivators", protagonists in regional projects run in Emilia Romagna, Lazio, Sicily and Tuscany.

At the same time the safeguard of the *Crop Wild Relatives* is an important task because this biodiversity is an indispensable genetic source for past, present and future breeding, utilized each and every time man needs to adapt cultivated plants to his changing needs. A promising strategy which up to now is only realized to a limited extent, could be the establishment of "Castles of Germplasm" (Avanzato and Engel, 2007), serving to safeguard existing plant genetic diversity *in situ*. What does this mean? Very simply: old castles have very often been built in high expositions and in locations which were difficult to access; consequently man has rarely interfered in these local ecosystems, thus leaving the spontaneous flora to its natural successions and developments. An impressive number of castles (more than 1.200) do exist in Italy and many of them are potentially useful as "Castle for germplasm". Impervious surroundings of the castles often develop ecologic conditions which favour the settlement of spontaneous flora. However, without the right care, this fragile equilibrium can easily be disturbed, for example by outbursts of fire. A simple erection of fences around the adjacent areas of the castles as well as the constructions of fire-breaking walls inside the territory would easily help defend either the plants (CWRs) and the traditions linked to the castles, which would itself become part of the protected sites. In this way, a close interaction would be stimulated, motivated by common interests, between the institutional organs dedicated to the safeguard of agricultural biodiversity and the environment (Ministry of Agriculture and Ministry of the Environment) and those dedicated to the recovery of historical sites (Ministry of Cultural Heritage).

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