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The renaissance of sericulture and return of Mulberry in the countryside

La renaissance de la sériculture : un renouveau économique pour des paysages productifs et durables

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Abstract

In Italy mulberry (*Morus nigra*) trees were introduced from China in the XVth century to improve silkworm rearing. At the beginning of XXth century, Italy was the second world producer of silk and mulberry was growing everywhere, planted as millions of pollarded trees along country roads, ditches, or in the middle of fields (see "coltura promiscua" system, a silvoarable system which was very common in the Northern Italian Great Plains) becoming a landmark in many Italian landscapes. After the Second World War the Italian sericulture activity was not able to adapt to the evolution of economy. Societies and traditional landscapes which were characterized by rows of pollarded mulberry disappeared within just few years. In recent years in Italy there was a renaissance of sericulture, due to different factors (new fashion trends, attention to product quality, etc). Mulberry production was lost in other European countries, but it survived in Italy, as both scientific and technical knowledge was maintained and the genetic resources needed to start silkworm rearing were preserved. As silkworm can only eat mulberry leaves, the renaissance of sericulture is giving a strong incentive to the return of mulberry trees in the countryside. Mulberry is an exotic species suitable to live in a large spectrum of ecological conditions in Southern Europe. It can survive at an altitude ranging from 0 to 800-1000 m above sea level and prefers slightly acid soils with deep and well drained soil structure. When young, it is a fast-growing species. There are more than 200 cultivars of mulberry and usually in a mulberry orchard is better to plant different cultivars to have a longer production of fodder along the spring-summer seasons. In "traditional systems", mulberries are planted in rows with an inter-row of 30-40 m, spaced every 6-8 m along the rows and the trees are pollarded at a height of 2.5-4 m. Modern plantations are very intensive (2000-3000 trees per hectare), with a spacing of 2.5-3.5 m x 1.0-1.6 m. The trees are pollarded at only 1 m height to facilitate mechanical harvesting of leaves.

Résumé

Le mûrier (*Morus nigra*) a été introduit en Italie depuis la Chine au XV^{e} siècle pour améliorer la reproduction du ver à soie. Au début du XX^{e} siècle, l'Italie était le deuxième producteur mondial de soie. Les mûriers étaient cultivés partout, plantés par millions, trognés le long des routes de campagne, des fossés ou au milieu des champs (voir le système de « coltura promiscua » dans le nord de l'Italie) devenant ainsi un point de repère dans de nombreux paysages italiens. Après la seconde guerre mondiale, la sériciculture italienne n'a pas su s'adapter à l'évolution de l'économie et les paysages traditionnels caractérisés par des linéaires de trognes de mûriers ont disparu en quelques années. Récemment, la sériciculture réapparaît en Italie en raison de différents facteurs (nouvelles tendances de la mode, attention portée à la qualité des produits, etc.). Ce retour de production fût possible car, contrairement à tous les autres pays européens, les connaissances scientifiques et techniques ainsi que les ressources génétiques nécessaires pour rétablir la reproduction du ver à soie ont survécu en Italie. Comme le ver à soie ne peut manger que des feuilles de mûrier, la renaissance de la sériciculture encourage fortement le retour du mûrier dans les paysages ruraux. Le mûrier est une espèce exotique appropriée pour vivre dans un large spectre de conditions écologiques dans le sud de l'Europe. Il peut vivre jusqu'à 800-1000 m d'altitude et préfère les sols profonds, légèrement acides et bien drainés. Jeune, c'est une espèce à croissance rapide. Il existe plus de 200 cultivars de mûrier. Il est préférable, dans un verger de mûriers, de planter différents cultivars afin de maximiser la production de feuillage. Dans les « systèmes traditionnels », les mûriers, espacés de 6 à 8 m, sont plantés en lignes, espacées elles de 30 à 40 m. Les arbres sont trognées à une hauteur comprise entre 2,5 et 4 m. Les plantations modernes sont très intensives (2000 à 3000 arbres par hectare), avec un espacement de 2,5-3,5 x

(Fig.1) The cultivation of mulberry crop for leaf production

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Introduction

The mulberry leaf is the only food source for the domesticated silkworm *Bombyx mori* and its ancient wild relative *Bombyx mandarina*. According to the most recent archeological findings, sericulture has been practiced since the Neolithic period, around 8500 B.C. (Gong et al., 2016) in China (Jiahu site). However, in Eastern Asia only mulberry cultivation was tightly linked to sericulture, while in Western countries the mulberry has ever been considered important for its fruit. It is widely believed that the mulberry tree spread through Europe from ancient times to the Lower Middle Age. The variety black bulberry (*Morus nigra*), native to Persia (Iran) was very well-known for the sweet taste and medicinal healing properties of its fruit. With regard to the white mulberry (*Morus alba*) introduction to Europe, this is certainly linked to sericulture, although historians do not agree on the exact period. In fact, probably at its very beginning, silkworm rearing was practiced in the Mediterranean regions by using *M. nigra* leaf, and only later farmers began to feed larvae with the leaf of *M. alba*. The first sure proof of the introduction of *M. alba* to Italy dates back to 1434 (Bettelli Bergamaschi, 1989), when Francesco Bonvicini "primum exoticam plantam in suam patriam advexit" (coming back from Far Eastern countries). However, particularily when *M. alba* production reached France, Italy, Spain, Portugal it was certainly related to sericulture, as it is better than *M. nigra* for this activity. The mulberry prefers slightly acidic, deep, medium mixture soils. It is a very robust and adaptable genus, with a rapid growth during the juvenile period. It has a great climatic adaptability, being spread at different latitudes; it belongs to the Family of Moraceae, Genus is *Morus* and Species are different: *nigra, alba, bombycis, multicaulis*..., with several cultivated varieties (cultivars) in the same species. Different mulberry species have undergone an intense selection, starting with openly-pollinated natural populations or with single individuals, which have been produced with a controlled hybridisation and subjected to mutagenesis. Therefore more than 1,000 varieties, including triploid, tetraploid and even esaploid varieties (Sanchez, 2000) were obtained. The mulberry has been selected for a very long time for the quantity and quality of the produced leaf, particularly the protein leaf content that ranges from 15 to 28%, being comparable with the amount of fodder legumes. The fibre content is lower than in other plants and the ash amount very high. Digestibility of leaf is very good as well as palatalability, so that its use has been proposed for ruminant but even for monogastric animals and there is sufficient literature to support this claim (Sanchez, 2000; Talamucci e Pardini, 1993; Micheletto, 2005). The mulberry fruit is a sorosis, which according to the species and variety and the ripening stadium, presents different colours from white to purple. Especially in the USA where some varieties of mulberry for fruit production have been selected.

Traditional cultivation systems

Until the half of the last century, the mulberry was systematically planted in the Italian plains and hilly landscapes, so contributing to the famous "Italian landscape" described by European writers and travelers. The most common form of cultivation were represented by rows intercropped with arable land ("piantata padana") (Ferrario, 2012) or planted at the edge of country roads and ditches. In this case trees, 1.7-2 m height or more, were planted at 6-8 m distance in the row and 30-40 m in the inter-row. The mulberry often acted as a living brace of the vineyard ("married vineyard"), thus resulting in a multifunctional system: leaf production for silkworms, timber production (mulberry wood was appreciated for multiple uses), firewood and grapes (Fig.1). There were other more intensive forms of cultivation of the mulberry (Lombardi, 1950):

- coppice (full field): in this case the distance between the rows were 3 m and the distance along the row was 2-2.5 m, with rectangular or quinconx layout ;
- meadow (full field): distance between rows of 1.10 m and along the row of 0.80 m ;
- hedge (margin of vegetable gardens and of fields): distance along the row of 0.75 m.

Modern cultivation systems

For over 60 years the loss of competitiveness of Italian sericulture has led to the progressive destruction of traditional agroforestry systems and the mulberry has remained as a "vestige" of a glorious past only. The resumption of interest in silkworm rearing that has recently been observed in Italy raises the question of the lack of fodder. For this reason, in the last few years, planting new mulberry orchards has begun to resume interest. The current tendency is to use the most intensive systems (coppiced, meadows). However, we should not underestimate the interest of cultivating rows of pollarded trees, even without the vineyard association, except for reconstruction of historical landscapes (for example in context of Venetian villas).

The advantage offered by silvoarable systems with pollarded mulberries is that the entire agricultural area remains available for arable crops, especially when rows are planted along ditches (which represent unproductive land), as it happens in case of the "ferrarese piana", a drainage system where there are 30-40 m among ditches draining the water towards canals orthogonal to them. In this case silvoarable systems have a density of 30-50 trees per hectare. Mulberry trees are endowed with deep root systems and horizontal root growth which require periodic root pruning due to soil cultivation; in this way competition with crops for water and nutrients is very low. Tree canopy is reduced by yearly branch cutting; this event, in addition to a wide spacing among trees, drastically limits crop competition for light; it is therefore conceivable (although there are no specific studies) that the LER (Land Equivalent Ratio) index is very favorable, so that the coexistence of 2 species on the same surface entails many environmental, landscape, naturalistic benefits (1 + 1 = 3!). Moreover, the "ditch-row" association is also classable as EFA (ecological focus area) and therefore contributes to the achievement of the targets imposed by the greening (articles 43 to 47 of the Regulation (EU) n.1307 / 2013). Another important aspect regards the possibility of a rationale mechanization of harvesting of the pollarded trees as it occurs in fruit farming (motorized or towed fruit harvesters).

The diffusion of modern agroforestry systems based on pollarded mulberries is locally strongly conditioned by Rural Development Regulations although the pollarded mulberry has currently a chance to characterize the landscape and the environment of the Italian countryside again: this is also linked to the revival of sericulture that is described in the following paragraphs (Fig.2).

(Fig.2) A modern agroforestry system

Sericulture is coming back: Italy, a special country for domestic silkworm production with the leaves of mulberry trees.

Sericulture has deep roots in Italy. This activity probably arrived to Italy because of the joint introduction by several actors (Arabs, Byzantins and perhaps Jewishes too), in several areas between the Xth and XIth century A.D. (Bettelli Bergamaschi, 1989). It grew almost uninterruptedly until the XXth century when a progressive reduction of production was recorded. The last silkworm egg production plant closed in 1978, although silkworm rearing in Veneto would have never completely stopped, on the basis of silkworm eggs imported from abroad. Italian silk industry delocalized reeling plants to China, while national ones had already been closed between 60's and 70's. At the end of the 80's, early 90's, a new opportunity appeared for Italian sericulture because of a sudden increase in the price of silk, but unfortunately a new disaster loomed over silkworm rearing. It was called "syndrome of no-cocoon spinning" (Cappellozza et al., 1990; Viggiani e Loia, 1991; Cappellozza e Burlini, 1992; Cappellozza et al., 1992; Plantevin et al., 1991), due to the pollution of the mulberry leaves (Arzone et al., 1989) by a pesticide that mimicks juvenile hormone (fenoxycarb), which was used on fruit trees (mostly apple trees) in springtime, to fight against leafroller moths (Lepidoptera Tortricidae). The vacillation of the Italian Health Ministry in facing the problem, with prohibitions in the use of the insecticide limited to some areas of Italy and

some periods only and later extended to the whole national territory and the illegal use by fruit growers, even in the presence of clear bans, especially in the first years of the active ingredient marketing, sentenced silkworm rearing definitely to death. Although silkworm rearing stopped in the 90's in the last century some favourable events made its revival possible between 2011-2012. It was only around 2011-2012, when fenoxycarb became obsolete and the use prohibition effective, due to insecticide stock exhaustion, which made it possible to rear silkworms again in Northern Italy. In addition other favorable conditions occurred

(Fig.3) Rearing, one step of the silkworm breeding

Availability of knowledge:

Two main Italian Institutions continued their activity over the complete period when virtual absence of silkworm rearing occured in the Italian territory. The first one, and surely the most important, was the sericulture seat of the CREA (Council of Research in Agriculture and Analysis of the Agricultural Economics), which is actually called "Moriculture and Sericulture Laboratory", of the Research Centre of Agriculture and Environment (CREA-AA); it was founded as Royal Sericulture Experiment Station in 1871, immediately after the conclusion of the Pasteur's studies on pebrine, in Padua (Veneto) and since that period it has uninterruptedly carried out research in sericulture with the objective of its practical applications; furthermore, it has always worked together with silkworm farmers and the silk industry for the introduction of updated advances in the sector and for technical assistance. It was thanks to the work of this Institute, joint to the research of the Turin University, that the cause of the syndrome of no-cocoon spinning was individuated and it was due to the great efforts of its staff, together with those of the representatives of the ANB (National Silkworm Rearers Association) that fenoxycarb was prohibited by the Health Ministry. This institution maintained and updated the know-how about silkworm rearing and was ready to guide the revival process, from the point of view of the technical aspects, when the chance to re-launch the sector occurred. The second Institute was Innovhub – Silk Division of Milan (former Silk Experiment Station), which has the capacity of giving assistance to the silk industry, in the field of silk protein application for biomedicine and cosmesis and in evaluating the silk quality on the basis of the silk thread characteristics. Furthermore, at the very beginning of the revival, the existence of some old farmers, still expert in rearing silkworm larvae and still preserving some rearing facilities and mulberry fields in the Veneto region, was of great importance (Fig.3). Last but not least, some elder workers of a former reeling plant have been available to transfer their knowledge to young people, one of whose had the chance of going to Japan for a brief training period (6 months) in an experimental reeling plant (NARO of Tsukuba).

Availability of genetics resources:

CREA-AA, in addition of being a research centre, is also a genetic bank. It has been preserving the Italian ancient silkworm strains, and even the French collection from INRA, since 2009. Furthermore, it has been preserving the mulberry cultivars that are of basic importance for leaf and fruit production (more than 60 varieties) (Cappellozza et al., 2013).

Availability of territory:

The lack of competitiveness of many agricultural traditional agricultural crops in comparison to the products of emerging countries and due to globalization, the abandonment of some marginal zones in hilly or mountain areas, the reduction in size of some agricultural farms, especially in the peri-urban belts, due to the expansion of cities, resulted in the availability of land for new agricultural uses. Due to its good impact on environmental indicators and to the possibility to be integrated with other agricultural or non-agricultural activities of farms (tourism,

landscape, soil defense...) sericulture can profit from the opportunity of being installed in these marginal soils and to be also practiced by "marginal human resources" (cooperatives of fragile persons, unemployed persons, immigrants, part-time workers...).

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