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LOW-INPUT APPLE PRODUCTION IN CENTRAL ITALY: TREE AND SOIL MANAGEMENT

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ABSTRACT

In Italy, apple production is currently centered in the Alps. Until the 1960s, dozens of traditional varieties were cultivated throughout the country. In Ancient Roman times, apple production was centered in the Apennine Mountains in south-central Italy. The varieties grown were 'Limoncella', 'Annurca', 'Gelata', which were superb in flavor, resisted diseases, and could be kept through the winter without cold storage. Efforts are currently underway to revive apple production in the Apennines by reintroducing the ancient varieties, interesting new disease-resistant varieties, such as 'Goldrush', and high-quality modern varieties, such as 'Gala', 'Fuji', 'Braeburn'. This program is mainly directed to those interested in low input or organic cultivation on small, hillside orchards at altitudes of 400 to 800 meters.

This program aims to reduce desertification, erosion and nitrogen leaching by improving soil quality and soil management. It also aims to give marginal farmers an opportunity for profit, a steady outlet in local markets, and eventually a role in providing high-quality traditional and organic fruit on the national market. Pilot orchards grow new cultivars together with traditional local varieties. Trees are trained as slender spindles, palmettes or open vases, taking into account the growth habits of the local varieties. Starting in the second year after planting, the soil between the rows is tilled and planted with a cover crop. Trees are usually grafted on semi-dwarfing rootstocks. Organic farming techniques are highly encouraged.

In villages in which the program is active, local markets are becoming saturated, which has piqued the interest of the national market. Consumers highly appreciate the colors and favors of the local apples. Small fruit size is still a problem, though improvements in fruit thinning and irrigation systems are expected to help. Some innovative, labor-saving training, pruning, and soil management techniques are presented and discussed.

Key words: Low-input production, apple, tree and soil management

Cultivated varieties and social, economic and ecological conditions

The industrial transformation underway in Italy since the 1960s has been confined mostly to the north of the country. In south-central Italy, significant industrialization has occurred only in limited coastal areas. In the North, rural areas have survived in the mountains of the Trentino-Alto Adige apple-growing region, or in lowland areas extensively planted with wheat and corn.

In south-central Italy, extensive emigration to the rich north has left the hilly inland rural areas abandoned. Mostly older villages have stayed in semi-abandoned villages and practice extensive agriculture, without new investments. The chief crop is durum wheat, used in the production of Italian pasta. The EU has invested heavily in durum wheat farming in order to prevent the total collapse of the rural economy in south-central Italy. Intensive horticulture and apple production in well-managed highland terraces has been completely abandoned as labor and market conditions steadily grow worse. Up until the 1950s, apple orchards in south-central Italy exported apples on the European market through the port of Naples. By the 1980s, apple production in south-central Italy had all but disappeared.

The hilly inland region of south central Italy is characterized by cold, snowy winters of variable severity. Minimum temperatures can reach -15°C. There is a high risk of late frosts until April. Precipitation is highest in the autumn, though heavy and unpredictable rains occur in the spring and summer. Drought can last from June until mid-August. Mean annual precipitation is about 750 mm, though it can reach 1500 mm in the mountains, where rainfall is much better distributed throughout the year.

The climate of south-central Italy is ideal for late-ripening apple varieties. Fruits form rapidly in the spring when temperatures are mild and sunshine is abundant. In June and July, drought reduces vegetative growth and the trees undergo a period of stasis typical for Mediterranean climates. The varieties traditionally cultivated in this region since Ancient Roman times, such as ‘Limoncella’, ‘Annurca’, ‘Zitella’, and ‘Mela Rosa’, are well adapted to the local climate and slow down their growth in the summer.

When the rains return in August, there could be large differences between daytime and nighttime temperatures. Fruit color begins to develop as the nights get colder. ‘Gala’ fruits take on a brilliant rich red color, but do not reach a large size. ‘Gala’ is harvested after the middle of September, a month later than in Emilia Romagna in Po river Valley. In autumn, late-bearing varieties take on size. Water core can be a problem because humidity and daytime temperatures are high.

In October, winter varieties have very firm flesh with high acidity. ‘Zitella’, a traditional sweet variety, has superb flavor at harvest, though a high percentage of the fruits have water core. ‘Limoncella’ and ‘Annurca’ have to be stored in open air under a rain shelter for at least two months until January to develop their characteristic flavor (Neri and Tanno, 1997). ‘Annurca’ takes on a dark red color.

'Limoncella' develops a green-yellow skin with a citric taste that keeps until the end of the spring. In the Marche region, 'Mela Rosa' can be kept without cold storage until April without losing its fine and much-appreciated taste. Some long-keeping and virus-free clones have recently been selected and released for new apple orchards (Virgili and Neri, 2002).

'Fuji' and 'Braeburn' have recently been introduced to increase production of high quality, much-appreciated apples. In south-central Italy, 'Golden Delicious' produces long fruits with firm, crunchy, juicy flesh and with an orange flush on the skin.

Training systems

Apple production had been traditionally carried out in a multi-layer system. Legumes and other vegetables, chiefly broad beans and local varieties of cabbage, were planted at ground level. Grape vines occupied the next level up. The level three to four meters above the ground was occupied by apples and other fruit species, such as olives, pears, plums, sorbs, medlars, figs, and quinces. Upright trees spaced far apart, such as cherries and walnuts, occupied the highest level. This mixed culture was carried out in terraces, and still survives in some small family gardens.

The most traditional apple training system was the open vase with a 1.5 m trunk. Trees grafted on rootstocks of local varieties were trained by heavy winter pruning. Generally, winter cleft grafting was carried out on three-year-old seedlings. The strong scion was cut back the next winter to the level at which scaffold formation was desired. During the second winter, three shoots were bent along inclined poles and cut back to the length at which secondary branches were desired. This pruning was generally repeated for four years. Trees began to bear only in the fifth year. It was difficult to manage these trees while standing on the ground, so small, one-meter tall step-ladders were commonly used. The trees lived long and were resistant to drought.

In our experimental and demonstration orchards, we modified the pruning techniques used in the open vase system for semi-dwarfing rootstocks so that the trees were lower to the ground and easier to manage. We used feathered grafted trees from the nursery and introduced green pruning. This greatly reduces vigor so that the smaller trees take on their final shape within three years. The shape is not regular, but efficiently promotes early bud differentiation. During the first two years, intensive lateral shoot formation is promoted by apical cutting in the spring and by shortening shoots in the summer. After two years, the trees have a bush-like shape with a center which is not completely opened. Starting in the third year, the tree shape and the number of fruit buds per tree are controlled by winter pruning.

A new dwarfing palmette training system, 'Pantograph', is now being tested in pilot orchards. Early cropping is encouraged by green pruning and shoot bending instead of by winter pruning. At planting time, the feathers are bent

horizontally using a plastic net as a wall frame. Only two vigorous shoots are bent at the base at a 45° degree angle and then cut back to 50 cm. The trees is then Y-shaped. New shoots coming from the cut will be used to form the 'Pantograph' during the spring and the summer of the first two years (Zucconi et al., 1998). All other shoots are bent horizontally two or three times during the growing season with the help of the net. The trees assume their final shape in only two years and should be planted at a density of at least 2500 plants per hectare.

All these new or modified training systems reduce the labor costs because the whole operation can be carried out from ground level, even by unskilled workers. In the south, spindle training is not reliable because the rootstocks are too vigorous. Palmette training can be used with good results for heavy bearing varieties such as 'Gala' and 'Golden'.

Labor is a major problem. A skilled worker may cost anywhere from 8 to 12 € an hour, and even an unskilled worker earns no less than 6 € an hour. It is especially difficult to find people at harvest time. Skilled workers for winter pruning are few and far between, so any training system that requires a lot of skilled labor for sophisticated pruning will not be cost-effective or practical. New pruning systems are being developed to reduce pruning to less than 100 hours per hectare, and to lower harvest expenses to less than one third of the cost of the apples.

The Italian government has recently approved a temporary permit for foreign workers so that fruit can be harvested all season long, from strawberries in March to apples and grapes in October. These workers are unskilled, but can easily be trained for green pruning and harvesting.

Cultural techniques

The reintroduction of apple orchards in Apennines requires very careful site selection. It is easier to prepare terraces on slopes steeper than 20° as long as the soil profile is maintained. On gentler slopes, the soil must be well drained using ditches to collect excess water. Orchards have to be monoculture to permit mechanization. A permanent inter-row cover crop consisting of nitrogen-fixing herbaceous plants together with slow-growing annuals and perennials ensures diversity, improves soil fertility and reduces erosion. Excessive competition between cover crops and trees can be reduced by frequent mowing.

Sustainability is essential. Cover crops fix nitrogen, mulching provides phosphorus and potassium, and soil microflora and mycorrhiza help transform nutrients into forms easily assimilated by the growing trees. For the first two years, compost or manure can be applied, 40 tons at planting, and 10 tons during the second year. This increases humus content, nutrient availability, and growth of the cover crops and the apple trees. Tilling between the rows helps control weeds, reducing competition for soil nutrients.

All these techniques help limit environment degradation by preventing soil erosion and nitrogen leaching, improving diversity, and reducing the amount of chemicals applied to the orchards (Neri, 1998).

Safeguarding the landscape by establishing more natural orchards improves the resort value of the local hillsides. This promotes tourism, which is a rapidly growing sector of the Italian economy.

Humification requires coenotrophy, which is the concerted interaction of a diverse microflora acting upon a polygenic substrate under micro-aerobic conditions (Zucconi 1996a, Fig. 1). Under coenotrophic conditions, production of humic compounds is very efficient, with little loss of carbon. Humification involves the initial degradation of organic polymers into soluble molecules which rapidly undergo polymerization and polycondensation to create even more complex structures (Zucconi et al., 1984).

Humic compounds are very important stable organic soil components with colloidal properties. They improve the physical, chemical, and biological characteristics of the soil, and help control allelopathy.

Modern agricultural not only disrupts the humification process, but also promotes the mineralization of humic substances in the soil and their subsequent assimilation by crop plants. This reduces sustainability and fertility because the humus content of the soil declines year after year. This problem is not usually taken into account in the nutrient and energy budget for crop production.

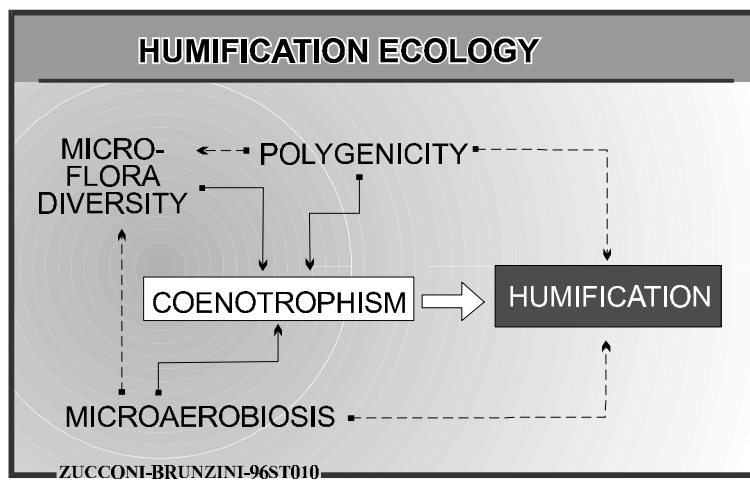

Figure 1. Humification requires a diverse microflora, a polygenic substrate, and micro-aerobic conditions (from Zucconi 1996a)

Erosion, mineralization, reduced humification, and reduced input of external organic matter have caused a dramatic decrease in soil humus content

in several Mediterranean countries. This has aggravated the generalized trend toward desertification.

In less than twenty years, several regions in Italy in which intensive agriculture is practiced have lost 1% of the organic matter content in the soil. In the upper 50 cm of the soil column, about 65 tons/ha of organic matter has been mineralized, releasing a total of two tons of nitrogen, or 100 kg/ha per year. This loss of humus means that more external organic matter needs to be added to the soil.

Humus creates an equilibrium which promotes plant growth, high quality production, and natural resistance to diseases and pests. Humus is one of the most important factors in sustainable agriculture. Even though other organic matter in the soil is subject to rapid mineralization, humus is mineralized at a very slow rate, about 1-2% a year. This means that humus can persist in the soil for decades, or even centuries.

"Soil sickness" refers to the progressive loss of soil quality due to the repeated culture of a single crop. It mostly affects the specific crop which has been repeatedly cultured, and less so other crops, especially if they are botanically unrelated (Zucconi 1993). Repeated monoculture of the same crop promotes the buildup of toxic substances in the soil, which disrupts the metabolic processes involved in coenotrophy. This reduces the conversion of organic matter into humus and lowers soil fertility. The impoverished soil is no longer able to support the growth of the same crop grown year after year. There are more frequent outbreaks of pathogens and parasites, which are usually falsely attributed to nutrient deficiencies or to increased pest populations. The real cause is usually disruption of the humification process.

CONCLUSION

Sustainable growing techniques allow new orchards to produce high-quality apples while improving the environment. The use of appropriate training systems which reduce labor and production costs can increase profitability in marginal areas of south-central Italy. Environmentally safe agricultural practices could enhance biodiversity while reducing erosion, nitrogen leaching, and the use of chemicals.

The new varieties, training systems, and cultivation techniques proposed in this paper can be integrated with those traditionally used in the hillside orchards of south-central Italy. This would enrich local genetic diversity. Consumers appreciate the more natural flavors of apples from the historical past, which have not been lost in the pursuit of commercial conformity. Quality apple production not only involves the production of large, beautiful apples, but also enhances the environment and the landscape while improving

the social and economic lives of producers and their neighbors for generations to come.

The decline in soil quality due to excessive cultivation, insufficient organic matter application, and disruption of the humification process cannot be allowed to continue. Sustainability can be restored by encouraging management of soil organic matter production in a way which closely mimics the natural process of humification, by encouraging the use of coenoses and organic amendments, by discouraging the use of pesticides and fertilizers, and by reducing soil tillage. Restoring humification efficiency would enhance natural processes which limit the spread of soil-borne diseases and pests. The healthy plants are less susceptible to pathogens and parasites, reducing the need for pesticides.

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ZRÓWNOWAŻONA UPRAWA JABŁEK W CENTRALNEJ CZĘŚCI WŁOCH: PROWADZENIE DRZEW I PIELĘGNACJA GLEBY

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S T R E S Z C Z E N I E

Obecnie produkcja jabłek we Włoszech zlokalizowana jest w centralnej części kraju. Jednakże do lat 60. jabłonie uprawiano w całych kraju Do tego czasu uprawiono dziesięć odmian jabłoni. W starożytności produkcja jabłek zlokalizowana była w południowo-centralnej części Włoch (Apeniny), gdzie uprawiano odmiany 'Limoncella', 'Annurca' i 'Gelata'. Odmiany te były bardzo aromatyczne, odporne na choroby i można je było przechowywać przez całą zimę. Obecnie wysiłki zmierzają do ponownej uprawy jabłoni w tym regionie przez wprowadzenie odmian atrakcyjnych dla konsumenta, a jednocześnie odznaczających się odpornością na choroby. Do takich odmian można zaliczyć 'Goldrush', 'Gala', 'Fuji' i 'Braeburn'. Hodowla ukierunkowana jest także na uzyskiwanie odmian odpowiednich dla upraw ekologicznych, które plonowałyby dobrze na wzniesieniach 400-800 m nad poziomem morza.

Celem rozwijania produkcji jabłek w centralnej części Włoch jest polepszenie jakości gleby przez zmniejszenie ugorów i odłogów, minimalizowanie erozji oraz wymywania azotu. Program ma na celu rozwijanie także lokalnych rynków sprzedaży owoców, co w konsekwencji ma zagwarantować rozwój małych gospodarstw. Na tym obszarze prowadzone są już pilotażowe sady, w których uprawiane są tradycyjne oraz nowe odmiany jabłoni. W sadach tych drzewa prowadzone są w formie wysmukłego wrzeciona, palmety lub w formie wazonowej. Od drugiego roku po posadzeniu jabłoni wzdłuż rzędów drzew stosuje się ugór mechaniczny, a w międzyrzędziach uprawę współrzędną. Jabłonie szczepione są na podkładkach półkarłowych i zasilane głównie nawozami organicznymi.

Obecnie lokalne rynki są „wysycone" owocami z ekologicznej produkcji. Duże zainteresowanie odmianami lokalnymi, które są dobrze wybarwione i aromatyczne, obserwuje się na rynku krajowym. Pewnym mankamentem lokalnych odmian jest zbyt mała wielkość owoców, co wskazuje na potrzebę silniejszego przerzedzania owoców oraz nawadniania. W pracy tej opisano systemy prowadzenia i cięcia drzew, które nie wymagają wysokich nakładów pracy, a także oceniono skuteczność ściółkowania w sadach.

Słowa kluczowe: zrównoważona produkcja, jabłoń, prowadzenie drzew i pielęgnacja gleby