

SOIL BIOTA, NUTRIENT CYCLING, and FARMING SYSTEMS

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CHAPTER 16

Research on Woody Plants with Low Energetic Inputs: First Results for the Land Suitability System on Ash Tree Manna *Fraxinus angustifolia* Vahl and spp. *Oxycarpa*

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ABSTRACT

Ash tree manna (*Fraxinus angustifolia* Vahl and subsp. *Oxycarpa* Bieb ex Wild) may be considered one of the most valid multipurpose trees used in afforestation. It has been cultivated in Sicily for about a thousand years, especially because of the numerous pharmaceutical uses of the manna.

An investigation was conducted toward improving the culture and its diffusion. We concentrated on individual environmental parameters (particularly those concerning the soil) that have a positive influence on the production and, when appropriately classed, give the Land Suitability Classification for this culture.

The first results show significant correlations between manna production and some soil features such as texture; depth; reaction; and contents of total nitrogen, assimilable phosphorus, and organic matter.

I. INTRODUCTION

Manna, a substance probably accumulated in the reserve organs of the ash tree, seems completely different from other natural exudates, e.g., from the rubber tree.

Ash tree manna has found an ideal habitat in the Madonie mountains, in Sicily. A millennial tradition of cultural techniques and harvesting methods have been hardly changed by time, thereby making the growing of ash tree manna (*Fraxinus angustifolia* Vahl and subsp. *oxycarpa* Bieb ex Wild) unique and probably unrepeatable in the world of arboreal culture. The variety Verdello is the most widespread and appreciated for both the quality and the quantity of its products.

Today there are 250 ha of ash tree groves. The irregularly spaced trees of different ages have an average density of 280 plants per hectare. The total number of trees in production is approximately 70,000.

The surfaces covered by ash trees are irregularly spread over a large area (approximately 4500 ha) around Castelbuono and Pollina (Figure 1), to the east of Palermo (Sicily, Italy). The general characteristics of this area are typical of the Sicilian coastal foothills, with steep and narrow valleys, steep slopes, and short torrent-like courses of water. The highest peaks range from 500 to 700 m above sea level (a.s.l.). According to Koppen, the climate of the area can be classified as Csa, i.e., a temperate type with hot, dry summers (Mediterranean climate).

A team of experts in soil science and horticulture conducted an investigation to help the revival of ash tree growing which seems destined to a slow but inevitable decline.

This chapter gives the preliminary results of this investigation which aims at identifying and characterizing the main environmental parameters, particularly those concerning the soil, which have a positive influence on the culture. Our eventual goal is to define environmental parameters useful for setting up the Land Suitability System for ash tree manna.

II. MATERIALS AND METHODS

Because this was a first attempt at establishing environmental and, in particular, soil parameters which are correlated to higher manna production and because the diffusion of ash tree groves is scarce, we chose to make a direct comparison between the soil features and manna production. The various factors which can influence the quantity of the production, i.e., the skill of the ash tree growers, the tree species, the tree age, the spacing, the growing techniques, etc. were considered as being standard and therefore of no influence.

During the first stage of the investigation a detailed survey was conducted to identify (from over the 200 different farms which produce manna and confer the product to the Consorzio Obbligatorio Produttori Manna) those which had the same characteristics regarding age, species, spacing, and growing techniques

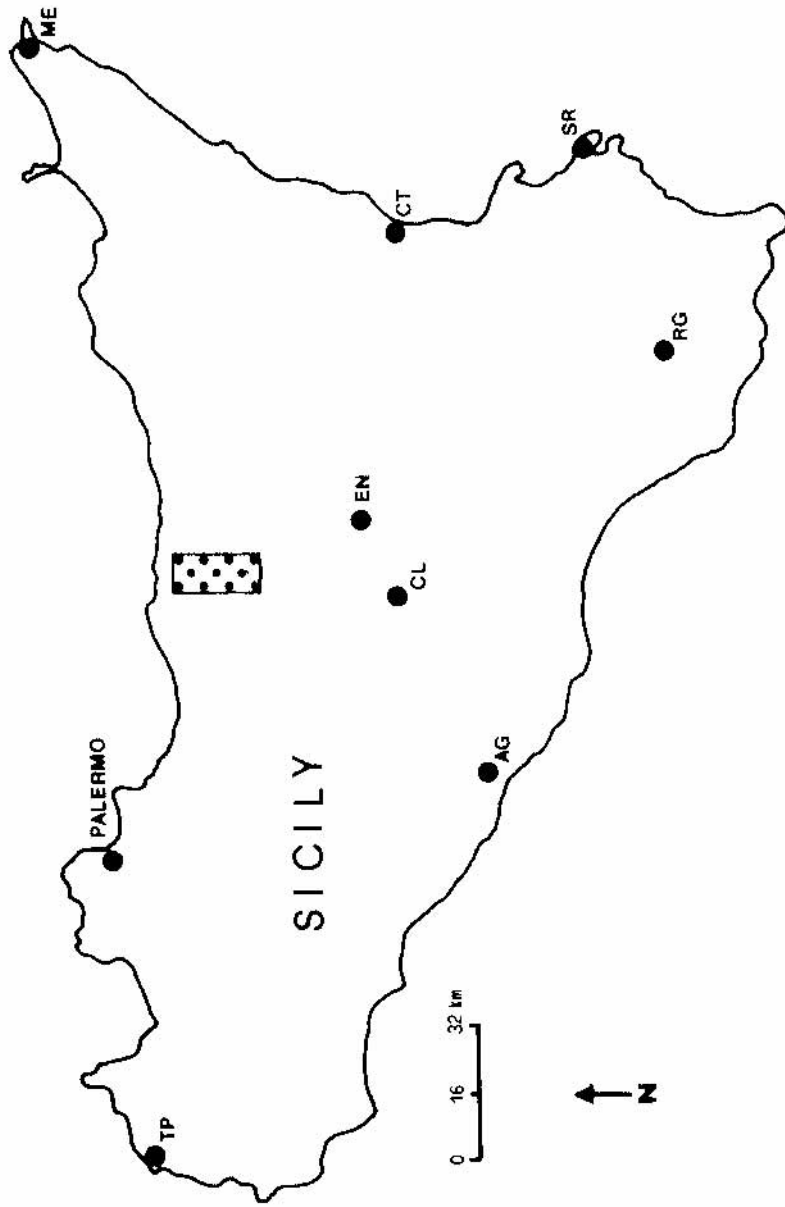


Figure 1. Schematic representation of Sicily. The test area is dotted.

Table 1. Production and Soil Type Found in the Farms Chosen for Farm Tests

Farm	Production (kg/tree)	Soil type (USDA)	
Castiglia	2.518	Typic	Haploxeralf
Raimondo M.	2.350	Typic	Xerochrept
Cinquegrani	1.617	Typic	Haploxeralf
Cortina	1.527	Vertic	Xerochrept
Solaro	1.170	Typic	Haploxeralf
Giambelluca	1.163	Udic	Haploxeralf
Mirena	0.967	Lithic	Xerochrept
Musotto	0.275	Typic	Xerorthent

but which had a widely different production rate. The rate ranges from a minimum of 0.275 kg per tree to a maximum of 2.518 kg per tree (Table 1).

A soil profile surveyed in the field, analyzed in the laboratory, and then classified according to the United States Department of Agriculture (USDA) System (Soil Survey Staff, 1975) was dug on each of the eight chosen farms during the period of manna production (July).

During the second stage of the investigation, after the laboratory analysis of the soil samples, the weighted mean for each investigated parameter was established for each profile. Then the arithmetic mean of the same parameter was calculated by dividing the value of the weighted mean by the number of profiles which are included in the three classes of manna production defined as: high production (>2 kg per tree); medium production (1–2 kg per tree); low production (<1 kg per tree).

III. THE SOILS

A detailed description of all the soil units surveyed goes beyond the scope of this chapter.* However, some general information about the main characteristics of each soil order is given.

The soils surveyed belong to the orders of Alfisols, Inceptisols, and Entisols, evolved on flichsoid sequences (in some cases on the prevailing clayey facies, in others on the prevailing sandy one) and show a xeric moisture regime and a thermic temperature regime.

Alfisols are characterized by a removal and transport of the clay which accumulates in the lower horizons. This process, which can be recognized by the granulometric composition (loamy-sandy-clayey on the surface, clayey in depth) and by the presence of clay skins on the surfaces of the peds, seems to be still active. It probably is favored by the abundant rainfall during the winter months but also by the absence of active limestone and by an acid reaction. Sufficiently drained on the surface, Alfisols show clear signs of water retention in depth.

* The description and the analytical data of the soils surveyed are available from the Soil Data Bank of the Chair of Pedology at Palermo University (Italy).

The structure is good with medium to coarse blocky and prismatic types which become crumb on the surface. From sub-acid to acid, Alfisols show a moderate to low cation exchange capacity, a desaturated exchange complex with a clear prevalence of ion calcium. The organic matter content is always low, except in the surface horizon. Nitrogen and phosphorus reach a sufficient level but only in the upper horizon. The potassium content is always low.

Inceptisols are characterized by a cambic horizon where the clay is mainly formed in situ, although in some cases a few clay skins on the surfaces of the peds have been noted. Drainage ranges from normal to slow as the depth increases. Texture, which on the surface ranges from loamy-sandy to clayey, is usually clayey in the deeper horizons. The ever evident structure shows fine and medium blocky types which tend to become prismatic in the B horizon. Neutral or slightly acid, non-calcareous, well supplied in organic matter in the upper horizon, Inceptisols show a moderate cation exchange capacity and an exchange complex dominated by the presence of ion calcium. Nitrogen and phosphorus reach a sufficient level but only in the upper horizon. The potassium content is always low.

Entisols show a slight differentiation from the parent material and clear signs of surface erosion. Texture is loamy-sandy, structure is moderate, and drainage tends to be slow. As a consequence the Entisols are slightly acid, non-calcareous, and moderately supplied in organic matter and have a low cation exchange capacity. The content of nutrient elements is good only in the few centimeters on the surface.

IV. THE RELATIONSHIP BETWEEN SOIL PARAMETERS AND MANNA PRODUCTION

Only a few of the various soil parameters surveyed showed some relationship with the three productivity classes previously defined.

A particularly interesting relationship between manna production and the following parameters was found:

- soil reaction
- total nitrogen content
- assimilable phosphorus content
- organic matter content
- clay content
- soil depth

Values of pH and production were noted, regarding soil reaction. In the three classes of productivity tested (Figure 2), pH was always sub-acid, but increased from pH 5.7 in the low productivity class to 6.6 in the high productivity class. A singular correlation resulted by comparing total nitrogen content of the soil with the productivity classes (Figure 3). The low productivity class corresponded to the highest total nitrogen value (0.131%), while the high productivity class corresponded to the low total nitrogen value (0.094%).

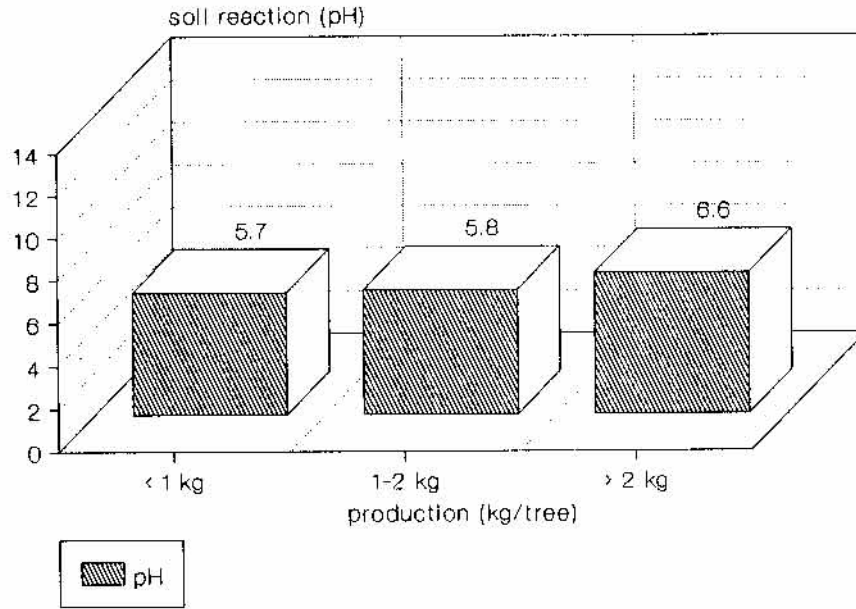


Figure 2. Correlation between manna production and soil reaction (pH).

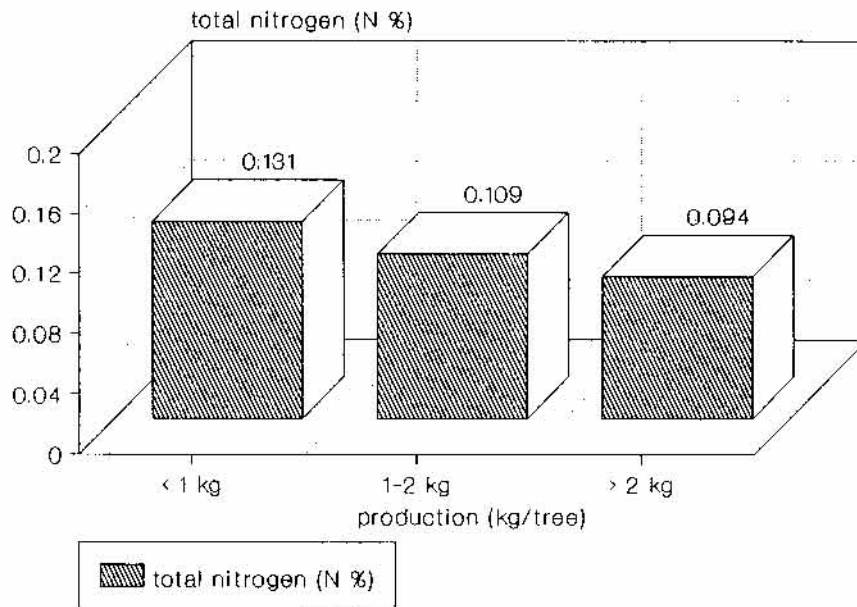


Figure 3. Correlation between manna production and nitrogen content.

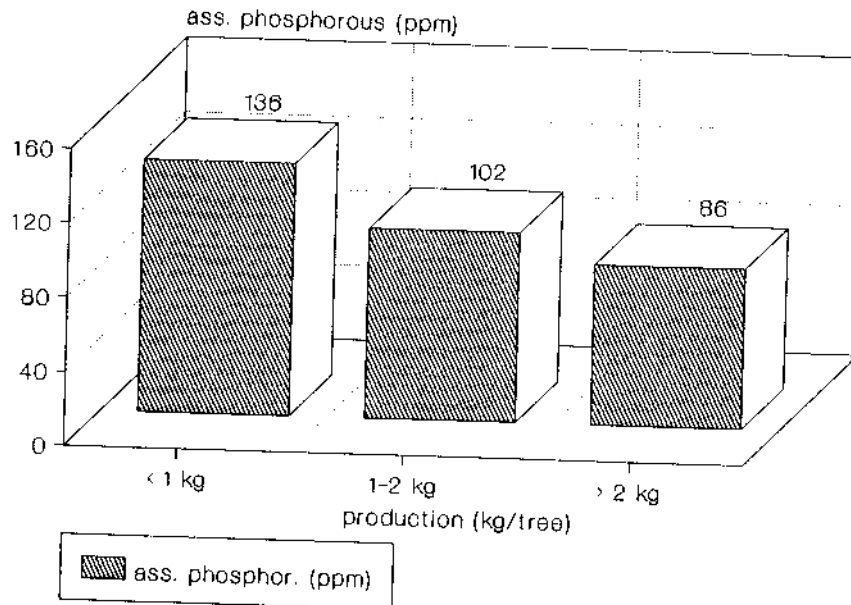


Figure 4. Correlation between manna production and phosphorus content.

A similar situation resulted for assimilable phosphorus (Figure 4). In this case too, the higher total phosphorus content (136 ppm) corresponded to the low productivity class, while the lower content (86 ppm) corresponded to the high productivity class.

An identical correlation was found with organic matter content (Figure 5). Higher production (>2 kg per tree) was obtained from soils with an organic matter content of 1.14%, while the lower production (<1 kg per tree) came from soils with an organic matter content of 3.04%.

The connection between the clay content and production was immediately obvious (Figure 6). The clay content increased as the production increased: the equivalent of 15% in the low productivity class (<1 kg per tree) became 46% in the medium productivity class (1-2 kg per tree) and reached 58% in the high productivity class (>2 kg per tree).

The connection between soil depth and production was equally obvious. When soil depth was not limited by the presence of particular horizons which could hinder or even prevent root development, it was found that production increased as depth increased (Figure 7). In soils with an average depths of 35 cm, manna production was less than 1 kg per tree while in soils with an average depth of 90 cm, manna production was more than 2 kg per tree.

V. CONCLUSIONS

The first results that emerge from our investigation show that the soils which have favourable characteristics for manna production tend to be clayey and deep.

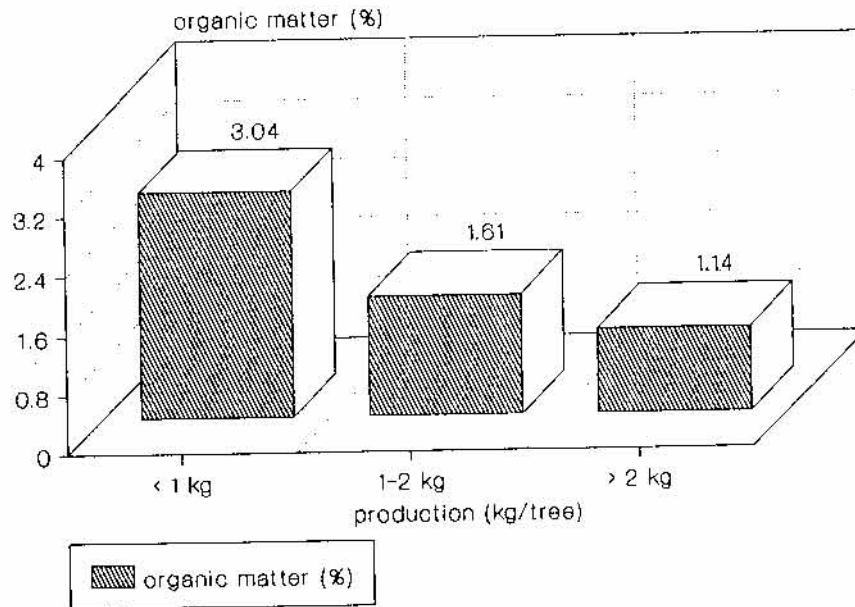


Figure 5. Correlation between manna production and organic matter content.

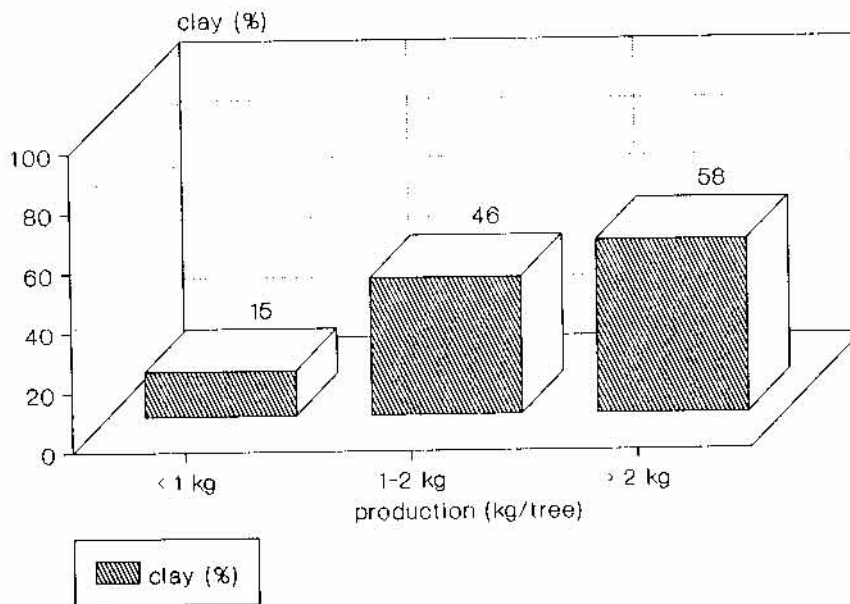


Figure 6. Correlation between manna production and soil texture.

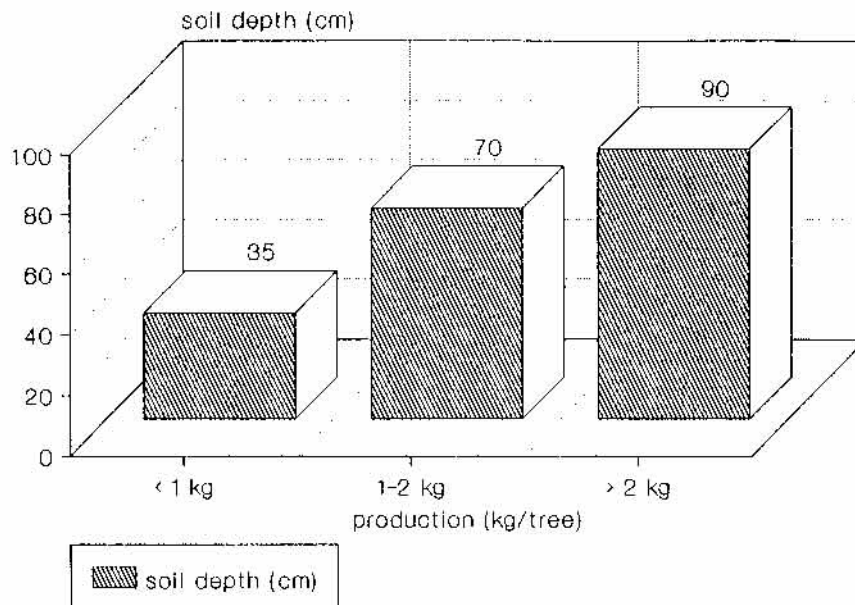


Figure 7. Correlation between manna production and soil depth.

It was noted that a progressive increase in production was correlated, within certain limits, to the physical characteristics of the soil ranging from coarse to fine soils and from shallow to deep soils.

No significant correlation was found with the soil reaction which tends to assume nearly neutral values for high production. Unusual connections were found between manna production and total nitrogen, assimilable phosphorus, and organic matter contents of the soils.

The reason for this is probably linked to the extreme rusticity of the ash tree manna which benefits from a low input for production. The period for production coincides with the plant's evident state of stress, while a thriving vegetation gives a negative effect, decreasing the production. The first incisions in the tree trunk to obtain manna are made when the tree is "mature", meaning that it is in a state of stress manifested by yellowing foliage which seems dry and shrivelled.

The first results of our investigation confirm the definition of ash tree manna as a tree species with a low input, considered only as a hypothesis up until now. There is little human intervention in managing an adult plantation, restricted to light pruning and in the best of cases, to intercropping with leguminous plants. These are modest inputs for a forestal species of primary importance for its rusticity and ability to supply a product (natural manna), which thanks to its main components (mannite, organic acids, glucose, levulose, etc.) and its recently identified minor components (cumarine) is being considered with renewed interest by official pharmacopocia.

The wood itself should not be neglected. It is obtained by a classical coppice with clear cutting or stump cutting conducted in turns of 11–25 years. The irreplaceable function of the species in hydrogeological and landscape defense on hilly environments should also be stressed.

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