



Farming System Design for Sustainable Agrifood Systems: theories and practices.

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**Marion CASAGRANDE, Marie-Hélène JEUFFROY,
Gentiane MAILLET**

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Agroforestry market gardening: lessons from farmers' practices in south-eastern France

VIAUD Reva¹, MICHEL Isabelle², MOITY-MAIZI Pascale³, PAUT Raphael⁴, WARLOP François⁵, SIEFFERT André⁶

¹ Université de Montpellier, CIRAD, INRAE, Institut Agro, Montpellier, France, ² INNOVATION, Université de Montpellier, CIRAD, INRAE, Institut Agro, Montpellier, France, ³ UMR SENS, Institut Agro, Montpellier, France, ⁴ Université Paris-Saclay, INRAE, AgroParisTech, UMR Agronomie, 91123 Palaiseau, France, ⁵ GRAB, Site Agroparc, 84911 Avignon Cedex 9, France, ⁶ ADAF, 225 route de la Laupie, 26160 Bonlieu-sur-Roubion, France

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Introduction

Over the past fifteen years, south-eastern France has seen a growing interest from both established and aspiring farmers in Agroforestry Market Gardening (AMG), cropping systems combining trees (mostly fruit trees) and market gardening on a plot. These systems promote biodiversity, diversify income and support agricultural adaptation to climate change. They are commonly found on small-scale organic farms relying on short supply chains (Léger et al., 2018). However, their structural complexity, mixing multiple annual and perennial species, makes them challenging to implement and manage. This paper explores farmers' experiences to identify obstacles and drivers influencing AMG sustainability.

Methods

In the French Mediterranean area, about 50 farms implementing AMG have been identified through previous research projects and local partners. All farms are organic, with most focusing on vegetables and/or fruits production, and AMG areas ranging from 0.1 to 3.5 hectares. Few farms are fully managed under AMG; most implement it partially. A sample of 20 farms has been selected for surveys based on the diversity of their histories and systems. Indicators for system characterization and insights into practices' evolution and their drivers over time were provided through semi-structured interviews and farm visits. An AMG cropping system is characterized by its spatial arrangement (alignment patterns and trees spacing), the number and types of species cultivated, along with management methods specific to its perennial (trees) and annual (market gardening) components, shaped by annual management routines. To account for and explain these practices' evolution, AMG cropping system trajectories were identified, drawing inspiration from Mawois et al. (2019). A trajectory is a succession of coherent phases (stable practices) interspersed with transition phases (driven by change processes). In this process, we primarily focused on design practices, as any change impacts the species components and their spatial arrangement within the system.

Results

Trajectories types are independent of AMG system design, which is mainly shaped by the plot's initial state. Each farm hosts one to two AMG systems; 28 were identified across the sample, aged 3 to 17 years. Based on the initial tree-vegetable intercropping and their evolution over time, four AMG trajectory types were defined (fig.1). Trajectory 1 involves introducing vegetable crops beneath already-established trees. Trajectory 2 involves planting trees on plots where market gardening is already established. Trajectory 3 describes the design of tree-vegetable association before any horticultural farming activity, on plots previously used for cereal cultivation or left as agricultural or forest fallow. Trajectory 4 refers to the temporary establishment of AMG favouring trees; market gardening is transitional.

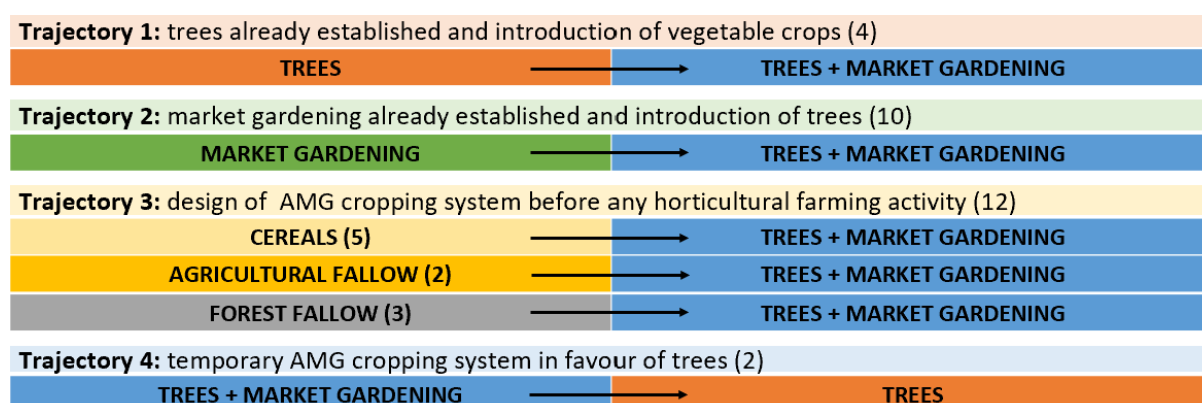


Figure 1: types of AMG cropping system trajectories within farms. Numbers in parentheses indicate the associated system count.

Within the same trajectory type, management changes differ over time. Figure 2 presents two examples of AMG cropping systems under trajectory 3. The first trajectory highlights numerous changes concerning tree component (fig.2A). Trees were planted gradually, starting with fruit trees to diversify income, followed by non-fruit trees to provide other services for vegetable crops. A lack of expertise in managing fruit trees and competition for water and light affecting vegetable crops, led to fruit trees partial removal, modifying the initial system design. Trees in the second trajectory were planted all at once, while vegetable areas expanded gradually as the farmer gains expertise (fig.2B). Training-led management changes mainly affected the tree layer, though adjustments in vegetable crops also occurred, seemingly unrelated to tree presence.

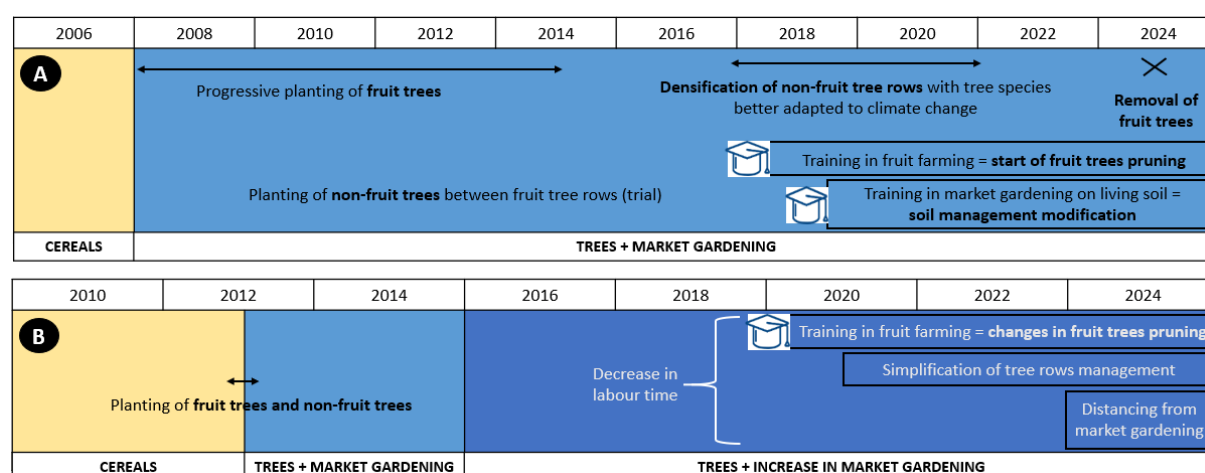


Figure 2: examples of two AMG cropping systems belonging to trajectory 3.

AMG cropping system design depends on the plot's initial state, meaning the presence or absence of prior horticultural farming activity and/or trees, as well as farmer profiles, including trainings, objectives and inspirations from other farms. Management changes during tree growth depend on AMG design, training received, and farmers' economic, organizational, and social constraints. In these systems, market gardening activity is mostly prioritized over fruit farming one, although a few farms focus more on fruit trees, leading the system to trajectory 4. This pattern is common among smallholder farms, where farmers shift to less time-consuming activities, such as processing, to offset income losses from market gardening. The overlap of market gardening and fruit farming inevitably requires work's reorganisation, and the need of dual expertise on the farm appears essential to prevent one activity from being side-lined.

Discussion and Perspectives

AMG cropping system trajectories highlight the need to adapt farm work to the contrasting temporal dynamics of horticultural activities (Paut et al., 2021) to improve both environmental (e.g., reducing soil tillage) and/or technical-economic performances (e.g., simplifying practices to reduce labour time) of the system. These systems evolve as farmers seek to achieve their objectives. Changes in agricultural practices resemble the design of a new working system shaped by a series of events and decisions (Chizallet et al., 2016). Most interviewed farmers have adjusted their AMG system through trials and failures and would take a different approach if starting over. These trajectories reveal patterns of tree-vegetable associations that correspond to different types of AMG cropping systems, some better suited to specific farm contexts based on their priorities, objectives and organization. Meanwhile, new AMG systems are emerging, trajectories have been described in detail in leaflets, offering valuable case-studies and lessons to inspire new project leaders.

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