Crop diversification and association to enhance the agroecological transition

Raphaël Paut, Rodolphe Sabatier, Marc Tchamitchian

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The greening of agriculture—whereby agricultural production dynamics are hinged on ecological processes—has led to a profound paradigm shift. This implies reaching beyond the prior management and control rationale, which sought to overcome environmental variability, so as to develop forms of agriculture adapted to local soil-climate conditions. Variability in environmental conditions is thus a key element to be promoted. In this setting a growing number of highly diversified systems are emerging, where fruit trees are combined with vegetables in so-called 'orchard-market gardening' agroforestry systems. It is essential to analyze the impacts of this diversification.

To this end, our research team is collaborating with extension and support structures (ADAF*, GRAB**, CIVAM***) to gain further insight into the functioning of these systems. The research carried out proposes analytical frameworks to measure and distinguish between the effects of mosaic diversification (without interactions between crops) and association (with interactions between crops) in mixed systems. This research is conducted on the basis of the portfolio theory to quantify the effects of diversification on risk, and the land equivalent ratio concept to measure the effects of association on yield. **Application of these theoretical precepts to a body of scientific literature revealed that associated horticultural crop systems outperformed systems under a mosaic approach in terms of yield and risk.** This research could be applied to design innovative cropping systems, in particular to sustainably boost their diversity. The findings could also have broader implications for other agricultural systems (cereal crops, livestock, etc.). Finally, in addition to the agronomic benefits of these systems, close attention must be paid to the impact of such diversification on the complexity of labor organization and management practices.

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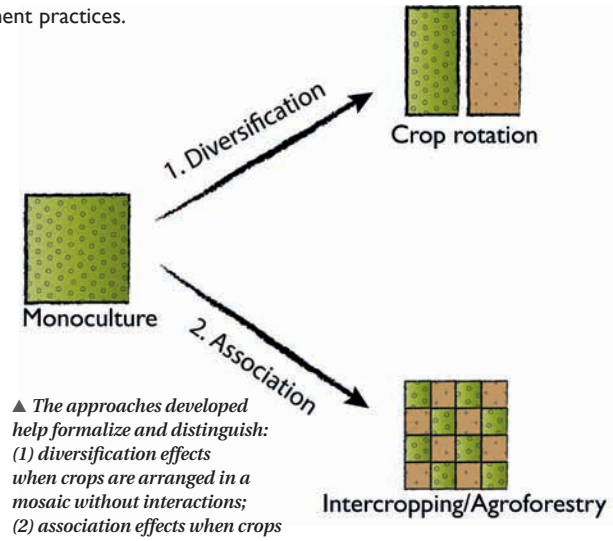
▲ *An example of a mixed fruit tree–vegetable crop system, in southern France.* © *R. Paut*



▲ *The approaches developed help formalize and distinguish: (1) diversification effects when crops are arranged in a mosaic without interactions; (2) association effects when crops are spatially associated.*

Bioturbation and ecosystem services in agroecosystems

Progress in scientific knowledge on soil ecological functioning has revealed that earthworms are emblematic of soil health and quality, and consequently of agroecology. While this aura of earthworms is fully justified due to their importance in nutrient cycling, soil organic matter protection, water cycling and soil erosion resistance, the role of termites—their tropical counterparts—has received surprisingly little attention[1]. **Like earthworms, termites influence soil functioning at different overlapping spatiotemporal scales and are hence discrete but major actors in tropical soils.** They boost soil fertility by enriching soils with clay and sometimes organic matter or bioavailable silicon for plants[2]. Termites live mainly in the soil and play the same role as earthworms by digging networks of galleries and cavities that increase the soil hydraulic conductivity and water retention capacity[3]. Yet their key feature is their ability to produce termite mounds that structure agricultural landscapes in Southeast Asia. By hosting specific flora and fauna[4], these mounds represent islands of fertility and biodiversity in agrosystems. They thereby provide a variety of ecosystem services, such as serving as refuges for biodiversity, improving plant productivity and contributing to the dietary diversity and health of local communities.

▲ *Termite mounds covered by specific vegetation that represent fertile biodiversity refuges in paddy fields. Cambodia, 2007.* © *P. Jouquet*

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