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Building resilience through ecosystem services

Transition to biodiversified agroecosystems

From process analysis to multiscale codesign with stakeholders

Functional plant biodiversity could be a way to enhance the agroecological transition of agroecosystems in tropical regions. A group of researchers studied the effectiveness of mobilizing and managing this biodiversity at different sites encompassing a broad range of conditions and types of systems*. **The holistic approach developed has led to the identification and hierarchical ranking of the main mechanisms linking biodiversity and ecosystem services**. The recycling function was thereby identified as predominant with regard to complex agroforestry systems on relatively poor soils in Cameroon, whereas pest control prevailed on rich Andosols in Central America. The plot spatial organization and biodiversity were found to be key levers for maximizing services. The quality of these services also depended on the long-term effects when plant biodiversity was introduced in rotations (e.g. weed control). **A generic analysis framework was drawn up to systemically unravel the direct or indirect impacts of plant biodiversity on agrosystem functioning and ultimately on ecosystem service provision.**

At the village community level, farmers should be supported in implementing specific design/adaptation mechanisms to modify their systems in favor of biodiversification. Participatory experimental approaches have been developed—sometimes using facilitation tools (foresight analysis, serious games)—to enhance learning and joint knowledge production, and ultimately to give farmers more freedom in these adaptive approaches. At the regional level, stakeholders having an influence on the conditions required for implementing these changes have been involved in co-innovation platforms. The aim is to give farmers more say and to ensure that all institutional actors are aware of their potential role in the transition process. Economic (for their market links) and political (for their policymaking weight) stakeholders are crucial in facilitating farmers' adoption of biodiversified agroecological systems.

* STRADIV project, System approach for the transition to biodiversified agroecosystems: www.agropolis-fondation.fr/STRADIV

▲ *Rotational rainfed rice cropping systems under legume cover (*Stylosanthes guianensis*) in Madagascar.*
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For further information

• Andreotti F., Speelman E.N., Van den Meersche K., Allinne C., 2020. Combining participatory games and backcasting to support collective scenario evaluation: an action research approach for sustainable agroforestry landscape management. *Sustainability Science*, *15*(5): 1383-1399.

• Resque A.G., Coudel E., Piketty M.G., Cialdella N., Sá T., Piraux M., ..., Le Page C., 2019. Agrobiodiversity and public food procurement programs in Brazil: influence of local stakeholders in configuring green mediated markets. *Sustainability*, *11*(5): 1425.

• Sauvadet M., den Meersche K.V., Allinne C., Gay F., de Melo Virginio Filho E., Chauvat M., Becquer T., Tixier P., Harmand J.-M., 2019. Shade trees have higher impact on soil nutrient availability and food web in organic than conventional coffee agroforestry. *Science of the Total Environment*, 649: 1065-1074.

The challenge of codesigning technically sound and polyefficient agroecosystems

Agroecosystem design (AED) currently has to take up the **triple challenge of diversification, climate change mitigation and adaptation, and food security**(1), while accounting for: (i) the multiple processes supporting ecosystem services (ES) at different scales—from field to landscape; and (ii) the diverse range of people involved—from farmers to regional stakeholders(2). Such complexification calls for key paradigm changes in the way the R&D sector has been working so far.

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AED should be systematically built on the characterization of **biophysical processes,** with a focus on their interactions at relevant scales, e.g. product types and quantities, pest and disease regulation, and nutrient cycling. Moreover, AED also should account for **management processes** at field and farm scales, e.g. available time, space and money, field techniques, end-product types and qualities and their links to value chains. **Integrating this data constitutes a wager and often a lock-in** that hampers optimum sustainable use of available resources (biophysical or managerial). Yet such characterizations—beyond their complexity—very often underline **trade-offs** between these processes[3]. These trade-offs should systematically be discussed with stakeholders and, when agroecological management initiatives are implemented, **stakeholders' goals and perceptions** of sustainable/ecofriendly agricultural management reveal **another set of lock-ins.** For instance, when implementing practices to boost soil carbon sequestration, it is essential to address challenges like knowledge voids, increased difficulty in conducting fieldwork, or risk handling and social pressure[4]. Step-by-step, R&D is striving to tackle these lock-ins and open the way to inclusive local knowledge, (co)innovation support and on-field experimental setup. This involves rethinking both agroecosystem modeling and its integration at multiple scales, while developing new multicriteria assessment approaches. Such approaches are currently being implemented in a wide range of projects*.

*Projects

COCOA4FUTURE, Putting people and the environment back at the heart of cocoa growing: www.cirad.fr/en/news/all-news-items/press-releases/2021/cocoa-growing-agroforestry-west-africa

DSCATT, Agricultural intensification and dynamics of soil carbon sequestration in tropical and temperate agricultural systems: https://dscatt.net/

BOOST, Collaborative platform on agroecological transition: www.boost-ae.net/en/1/home.html

FAIR, *L'intensification agroécologique pour la résilience des exploitations dans le Sahel*: www.fair-sahel.org/

STRADIV, System approach for the transition to biodiversified agrosystems: https://stradiv.cirad.fr/

ASSET, Agroecology and safe food system transitions in Southeast Asia: https://ur-aida.cirad.fr/en/our-research/research-projects-and-expertises/asset

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For further information

(1) Saj S., Torquebiau E., Hainzelin E., Pages J., Maraux F., 2017. The way forward: an agroecological perspective for climate-smart agriculture. *Agriculture, Ecosystems & Environment,* 250: 20-24.

(2) Corbeels M., Cardinael R., Naudin K., Guibert H., Torquebiau E., 2019. The 4 per 1000 goal and soil carbon storage under agroforestry and conservation agriculture systems in sub-Saharan Africa. *Soil and Tillage Research*, 188: 16-26.

(3) Andreotti F., Mao Z., Jagoret P., Speelman E.N., Gary C., Saj S., 2018. Exploring management strategies to enhance the provision of ecosystem services in complex smallholder agroforestry systems. *Ecological Indicators*, 94: 257-265.

(4) Demenois J., Torquebiau E., Arnoult M.H., Eglin T., Masse D., Assouma M.H., Blanfort V., Chenu C., Chapuis-Lardy L., Medoc J.-M., Sall S.N., 2020. Barriers and strategies to boost soil carbon sequestration in agriculture. *Frontiers in Sustainable Food Systems*, 4.

Promises and limits of agroecology in sub-Saharan Africa

An illustration in the Hautes Terres *region of Madagascar*

There are three recognized ways of greening agriculture. Agroecology 'of practices' aims to transform 'conventional' systems but without affecting agrifood system governance or the priority of maximizing volumes and profits. Ecological intensification of practices concerns systems that have been barely or not at all impacted by the Green Revolution. Finally, integral agroecology, i.e. systemic and territorial, is more political and advocates a break with industrialization while striving to optimize a set of services in a balanced system. The prospects of these different approaches are presented with regard to their application in the *Hautes Terres* region of Madagascar. Despite the real potential for development, agricultural policies focused on conventional intensification (widely promoted) or on ecological intensification of farming practices have had little impact in this region.

▲ ***Along the road.*** *© V. Lebourgeois/CIRAD*

The Analamanga, Itasy and Vakinankaratra regions of Madagascar hosted more than 800,000 farms in 2018, compared to 540,000 in 2005. This led to an almost twofold decrease in the average size of family farms (currently less than 1 ha). Resources and production capacities are so limited that agricultural innovations in the form of simple technical packages have little impact. Innovations must apply to the overall and yet quite diversified activity system—including off-farm activities—in order to have an impact in the best-off family farms. Yet these innovations will not be sufficient unless accompanied by economic diversification within the the region. In the *Moyen Ouest du Vakinankaratra*, i.e. a less saturated region, agricultural development is hampered by the lack of elementary services, in quantity and quality (health, education, roads, market equipment and, above all, security). **Technical responses are therefore ineffective levers. Structural bottlenecks stand in the way of positive change without massive and coordinated public action at the farm, sectorial and territorial levels. Agroecological strategies must therefore be integral, jointly oriented towards systemic and territorial approaches.** Technical solutions will only be able to offer real leverage to families in the *Hautes Terres* region when a favorable socioeconomic environment prevails.

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For further information

• Sourisseau J.-M., Bélières J.-F., Marzin J., Salgado P., Maraux F., 2019. The drivers of agroecology in sub-Saharan Africa: an illustration from the Malagasy Highlands. *In* Côte F.-X. *et al.* (eds): *The agroecological transition of agricultural systems in the Global South*. Ed. Quae, Versailles: 179-197. www.quae-open.com/produit/114/9782759230570/the-agroecological-transition-of-agricultural-systems-in-the-global-south

• Rakotoarisoa J., Bélières J.F., Salgado P., 2016. *Intensification agricole à Madagascar : politiques publiques et trajectoires d'exploitations agricoles du Vakinankaratra*. Summary report. CIRAD-FOFIFA, Antananarivo, 135 p. https://agritrop.cirad.fr/583105/