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Spatial organization of individuals and ecosystems services in tropical agroecosystems

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Background/Question/Methods

Agroecology involves the optimization of ecological processes in agroecosystems. It has been identified as a sustainable alternative to the negative environmental impact of modern agriculture. A challenge in agricultural research is to design innovative ”agroecological” systems: allowing to maintain an acceptable level of productivity; but also fostering on other ecosystem services.

We worked on ecological concepts influencing the dynamics and ecological performances in ecosystems, and studied its application on agroecosystems.

The spatial organization of individuals is fundamental in ecological theories. It is an important structural characteristics that influence ecosystem functioning and productivity. In agroecosystems, the spatial organization of individuals may influence key aspects influencing ecosystem services sought-after in sustainable agriculture.

Our aim was to analyze the spatial organization of plant individuals in complex agroecosystems; and to highlight the links between spatial organization of plant individuals and selected ecosystems services: provisioning services (crop productivity), biodiversity conservation (trees species richness) and regulating services (pest and disease regulation).

We used the Ripley function to analyze the spatial organization of shade and cacao trees in cacao agroforests in Costa Rica. We also assessed the species richness of shade trees; and cacao productivity and damages by Frosty Pod Rot, an important disease in Costa Rica.

Results/Conclusions

Three types of stands were identified: the first characterised by significant clustering of shade trees. The second type was characterised by random spatial organisation of shade trees. The third types showed a trend towards regular organisation.

The clustered structure of shade trees appears to be a trade-off between biodiversity and productivity. Even if the damaged production (estimated by the number of damaged pods in the plots) was significantly higher in the clustered type, the potential (total number of pods) also tended to be higher, leading to an healthy (number of healthy pods) productions equivalent to the regular and the random spatial types. However, the clustered type had the highest shade tree species richness.

The clustered type were located in remote places, closer to natural forest systems, and are managed for years by farmers who are very respectful of nature, and do not wish to disturb the natural process of tree regeneration.

Manipulating spatial structure in complex agroecosystems appears as a lever for the ecological intensification of these agroecosystems. Indeed, the clustered spatial structure appears to favour a synergy between biodiversity conservation (tree species richness), and provisioning services (cacao production), taking into account a regulation

services (pest and disease regulation).

Abstract ID#: 43927
Password: 355328
Title: Spatial organization of individuals and ecosystems services in tropical agroecosystems
Preferred Presentation Format: Oral
Submitter's E-mail Address: marie-ange.ngo_bieng@cirad.fr
Place in an Organized Oral Session: Yes
Organized oral session preference: Population, Community and Ecosystem Collapse and Recovery: Lessons Learned and Remaining Challenges For The Future Of Ecosystem Management
Themes:

1. Subdiscipline - agroecology/agroforestry
2. Ecological applications, tools, and techniques - spatial analysis and gis
3. Ecosystem or habitat - agricultural systems

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