# Substitution of tolerant for sensitive species balances ecosystems in agricultural areas, study says

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Research conducted in manipulated sugarcane plots showed that small water bodies such as ponds and puddles can contribute to sustainable farming even with environmentally hostile practices. Credit: Edmar Mazzi/CENA-USP

Contributing to the pursuit of sustainable farming, especially sugarcane growing, Brazilian researchers have shown that water bodies such as ponds and even puddles can maintain ecosystem services, provided there

are tolerant animals in the vicinity to replace those most sensitive to agricultural practices.

In an innovative study involving manipulation of large areas of cropland, the group tested the effects of intensifying land use by converting extensive pasture to intensive pasture and sugarcane plantations in Southeastern Brazil. The experimental plots contained 4,000-liter mesocosms simulating ponds and puddles commonly found in productive landscapes. Mesocosms are enclosed environments that allow a small part of a natural environment to be observed under controlled conditions.

Despite application of insecticides and vinasse to the sugarcane, the biomass in the habitat remained stable in all three settings. This was only possible because, after application of the products, colonization by tolerant mid-ranking predators such as beetles and bugs offset local extinction of a sensitive top predator (a dragonfly). As a result, community stability tended to increase with biomass asynchrony and species richness, evidencing a "portfolio" effect of biodiversity, with the advent of new species offsetting the disappearance of others.

"We demonstrated experimentally that the functioning of aquatic ecosystems in agricultural environments can be maintained despite harmful practices, as long as there are tolerant species coming from outside the plantation to replace more sensitive species. The indicator we used for ecosystem functioning was animal biomass production in terms of the number of grams observed over time. We found that it remained constant even in cane fields."

"This is very interesting from the standpoint of the discussion about the importance of biodiversity in maintaining local ecosystem services, among other functions," said biologist Luis César Schiesari, a professor of environmental management at the University of São Paulo (USP) in Brazil, and first author of an article on the study published in the *Journal*

*of Applied Ecology*.

## Sustainability

Previous research showed that this supply of species is not available in real croplands, where aquatic ecosystem biodiversity is comparatively impoverished. The authors therefore recommend that crop management practices include protection for swamps, marches and ponds on the edge of croplands to serve as water bodies for species colonization and providers of biodiversity.

"These organisms are beneficial for crops. They feed back into the ecosystem and also prey on crop pests. Insects and amphibians lay eggs in temporary puddles. The larvae that hatch from the eggs feed on the aquatic environment and later metamorphose into terrestrial adults. The adults may die in the terrestrial environment, 'exporting' the matter that accumulates in the puddle, including nitrogen, phosphorus and potassium, back into the plantation. These ecosystem functions satisfy the premises of sustainable precision agriculture," Schiesari told Agência FAPESP.

Mitigating environmental impacts on supply chains and managing the effects of climate change to promote sustainable development are high on the global agenda. In this context, agricultural production and the energy transition to clean fuels and renewables are a focus for worldwide attention.

As the world's leading producer of sugarcane and one of the leaders in ethanol, for some years Brazil has discussed the sustainability of this supply chain and the socio-economic cost of land use in the sector. Sugarcane production is set to rise 4.4% in the crop year 2023-24 compared with the previous year, reaching 637.1 million metric tons, according to CONAB, the federal government's food supply agency.

"In my line of research, I try to understand how changes in the environment due to human activity affect biodiversity," Schiesari said. "Specifically in the past 15 years, I've focused on understanding the consequences of the conversion of native habitats such as forests and savannas to pasture, and the intensification of pasture in areas of soybeans, sugarcane and other kinds of monoculture farming. This process of conversion and environmental intensification entails structural, physical and chemical changes."

Pasture is the main land use throughout Brazil, accounting for 152 million hectares and present in six biomes, according to a report by MapBiomas, a collaborative network formed by NGOs, universities, and technology startups dedicated to mapping land cover and land use in Brazil. That is practically equivalent to the area of Amazonas state, which is 156 million hectares.

## Stages

The study area was part of an experimental farm belonging to the São Paulo's Agency for Agribusiness Technology (APTA) in Brotas. It was divided into 15 plots measuring 50m by 50m. Five were extensive pasture without prior soil preparation or tillage, and with grass growing naturally in accordance with fertility in the area. Another five were converted to intensive pasture with soil grading using tractors, liming to raise soil pH, fertilizing, and planting of Brachiaria forage grass, widely used for both intensive and extensive pasture in Brazil.

Sugarcane was grown on the other five plots, using technology, inputs and management practices similar to those used by growers in Brazil. Cuttings were suitable to the soil and climate. Fertilizer and insecticide were applied, as well as vinasse, the final residue from fermentation of sugarcane juice to obtain ethanol. Vinasse promotes growth of bacteria and consumption of oxygen when discharged into aquatic ecosystems.

The researchers set up 18 aquatic mesocosms, each with 4,000 liters of water in ponds and puddles. They tracked the mesocosms' physicochemical parameters, nutrients, pesticides, phytoplankton and spontaneously colonizing biodiversity.

"Our research was conducted in a single season with temporary puddles, an intrinsically transitory model ecosystem. Future studies should test the long-term consequences of land use, exploring the effects of the landscape context, and hence of spatial isolation and limited dispersal, on the capacity of the pond communities to keep biomass production stable despite dangerous management practices," Schiesari said.

**More information:** L. Schiesari et al, Community reorganization stabilizes freshwater ecosystems in intensively managed agricultural fields, *Journal of Applied Ecology* (2023). DOI: 10.1111/1365-2664.14423

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