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PERSPECTIVES

Can rice field management practices contribute to the conservation of species from natural wetlands? Lessons from Brazil

Leonardo Maltchik[a,*], Cristina Stenert[a], Darold Paul Batzer[b]

[a]*Laboratory of Ecology and Conservation of Aquatic Ecosystems, Av. Unisinos, 950, CEP 93.022-000, UNISINOS, São Leopoldo, RS, Brazil*
[b]*Department of Entomology, University of Georgia, Athens, GA, USA*

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Abstract

A major goal of worldwide agriculture over the next 30 years will be to feed a burgeoning population of about 9 billion people. This expansion poses a great challenge because crop production is an activity that profoundly affects natural habitats and biodiversity. An interesting perspective for biodiversity conservation is the incorporation of production systems into overall conservation efforts. Rice is one of the world's major crops and Brazil is the leader in the Western Hemisphere with 35% of the cultivated area. Rice fields are sometimes considered man-made wetlands with potential values for many aquatic species. The main goal of this paper is to synthesize results of studies carried out over the past decade in rice fields of southern Brazil to identify management practices that enhance biodiversity levels in agricultural matrices. We also provide direction to environmentally-oriented legislators for implementing general strategies for rice farmers to supplement aquatic diversity of natural wetlands. Major techniques include: 1) keeping some rice fields flooded during the fallow phase; 2) increasing organic rice production to reduce the use of pesticides; 3) encouraging rice farmers to rejuvenate soils by periodically taking fields out of production; and 4) avoid draining new wetlands for rice production. Incentivizing good management practices in rice fields would transfer some of the responsibilities related to the conservation of biodiversity to production systems.

Zusammenfassung

Ein wichtiges Ziel der weltweiten Landwirtschaft für die nächsten 30 Jahre ist, eine wachsende Bevölkerung von rund 9 Milliarden Menschen zu ernähren. Dieser Zuwachs stellt eine große Herausforderung dar, weil die landwirtschaftliche Produktion die natürlichen Lebensräume und die Biodiversität beeinflusst. Eine interessante Perspektive für den Schutz der Biodiversität ist, die Produktionssysteme in die Schutzbemühungen einzubeziehen. Reis ist eine der wichtigsten Feldfrüchte, und Brasilien ist mit 35% der Anbaufläche der führende Produzent in der westlichen Hemisphäre. Reisfelder werden manchmal als menschengemachte Feuchtgebiete mit potentiellem Wert für viele aquatische Arten angesehen. Das Hauptziel dieses Artikels ist, die Ergebnisse von Studien zusammenzuführen, die in der letzten Dekade in Reisfeldern von Süd-Brasilien durchgeführt wurden, um Bewirtschaftungsweisen zu identifizieren, die die Biodiversität in der Agrarlandschaft fördern. Wir geben auch Hinweise an umweltorientierte Gesetzgeber zur Implementierung allgemeiner Strategien, mit denen Reisbauern die aquatische Diversität von natürlichen Feuchtgebieten ergänzen können. Die Hauptmethoden sind: 1) Einige Reisfelder sollten während der Brachezeit überflutet bleiben. 2) Der biologische Reisanbau sollte verstärkt werden, um den Pestizideinsatz zu verringern. 3) Die Reisbauern

*Corresponding author. Fax: +55 51 35908122.
E-mail address: maltchik@unisinos.br (L. Maltchik).

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sollten ermutigt werden, die Böden durch regelmäßige Nichtbewirtschaftung zu regenerieren. 4) Es sollten keine zusätzlichen Feuchtgebiete für den Reisanbau entwässert werden. Mit dem Anreiz für eine gute Bewirtschaftungspraxis auf den Reisfeldern würde ein Teil der Verantwortung für den Erhalt der Biodiversität auf die Produktionssysteme übertragen.

Keywords: Agricultural policies; Agricultural systems; Agroecosystem; Organic rice; Paddy fields; Sustainable farming

Introduction

Agriculture in the next 30 years will need to feed a human population that reaches about 9 billion people (Bloom 2011). This poses a great challenge for agriculture (Tilman, Balzer, Hill, & Befort 2011) because crop production has already negatively impacted natural habitats and their resident species (Foley et al. 2005, 2011; Power 2010). Agriculture today covers approximately 38% of the global land surface, of which 12% are croplands (i.e., 1.2 billion ha; FAOSTAT 2013). Any forecast in agricultural expansion is of concern from an environmental perspective. The challenge for modern agriculture lies in assuring food for a burgeoning population, while preserving both natural habitats and biodiversity (Gaba et al. 2015).

Currently, a major strategy to conserve biodiversity is the establishment of protected areas. Butchart et al. (2015) estimated that protected areas across the world currently comprise 14.6% of the land surface, however, this percentage is concentrated in certain regions, not ensuring species conservation in other ecoregions, biomes and key locations. An interesting perspective to consider from the biodiversity conservation point of view is the incorporation of production systems such as agriculture into conservation efforts (Brussaard et al. 2010; Phalan, Onial, Balmford, & Green 2011). Land sharing (to integrate biodiversity conservation and food production on the same land) and land sparing (to separate land for conservation from land for food production) are agricultural strategies (Green, Cornell, Scharlemann, & Balmford 2005; Fischer et al. 2008; Gabriel et al. 2009) to minimize the impact of food production on biodiversity (Phalan et al. 2011). Godfray and Garnett (2014) maintained that the sustainable management of agricultural lands could contribute significantly toward reducing the negative impacts of agriculture on biodiversity and natural ecosystem services.

Rice is the third most cultivated crop in the world, occupying about 13% of the world's cropland area (164 million ha) (FAOSTAT 2013). Asia accounts for 89%, followed by the Western Hemisphere (5%), where Brazil is the leader with 35% of the cultivated area (FAOSTAT 2013). Irrigated rice fields are considered man-made wetlands by many wetland classifications (e.g., Neotropics, Scott & Carbonell 1986; Asia, Scott 1989; global, Ramsar Convention Bureau 1990). The most recent Brazilian wetland classification (Junk et al. 2014) also labels rice fields as wetlands. Irrigated rice fields provide habitat for many species of wetland invertebrates, plants, fish, amphibians, and birds (Table 1). Natuhara (2013) suggests that ecosystem services from rice fields may provide many of the same values provided by natural wetlands. Recently, a pioneer project (LEGATO – "Land-use intensity and Ecological enGineering – Assessment Tolls for risks and Opportunities in irrigated rice based production systems") conducted in South-East Asia explored new opportunities to enhance sustainability of irrigated rice fields (Settele et al. 2015), including practices tied to rice cultivation influences on biodiversity. Katayama, Baba, Kusumoto and Tanaka (2015) identified policies to decrease the impacts of rice fields on natural biodiversity (e.g., bans on pesticides and herbicides; decreases in chemical fertilizer application, using more efficient machinery and irrigation processes; and fiscal incentives to farmers who protect fields after abandonment).

In the Americas, Brazil is the largest rice producer accounting for 32% of the production (USDA 2015). Research related to biodiversity conservation in irrigated rice fields in Brazil is still rare (e.g., Stenert, Bacca, Maltchik, & Rocha 2009; Rolon & Maltchik 2010; Guadagnin, Peter, Rolon, Stenert, & Maltchik 2012; Linke, Godoy, Rolon, & Maltchik 2014). The southern portions of Brazil contribute almost 50% of the national production of rice (IRGA 2013). Irrigated rice production has been a major contributor to the fragmentation and loss of natural wetlands (Maltchik 2003). Southern Brazil is located in the Pampa biome, which is highly impacted by various human activities; the region has numerous endemic species but very little area under protection (<1%), with about half of it protecting wetland systems. In view of this, the question arises: Can such a small area adequately protect wetland aquatic biodiversity? Thus, incorporating production systems into biodiversity conservation may be an intriguing way to conserve high levels of species richness in a rice cultivation matrix. This concept is not new for agriculture, and the idea has attracted attention across the world (CEC 1985; Brussaard et al. 2010; Phalan et al. 2011).

This paper synthesizes results of numerous studies conducted over the past decade in irrigated rice fields of southern Brazil to identify management practices that enhance wetland biodiversity levels in an agricultural matrix. Our goal is to reconcile environmental and agricultural interests. We will address three major questions: (1) Does flooding of rice fields after cultivation contribute to species conservation? (2) Can organic rice production contribute to the conservation of biodiversity of natural wetlands? and (3) Does the intensity