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SPECIAL FEATURE

Promoting multiple ecosystem services with flower strips and participatory approaches in rice production landscapes



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Abstract

Habitat management needs comprehensive perspectives, considering multiple ecosystem services at local and landscape scales. Stakeholder involvement with participatory research and development programmes for farmers is an essential part of it. Currently, ecological engineering by habitat management and participatory programmes and mass media campaigns are developed to counteract the adverse effects of ongoing intensification of rice production in Southeast Asia. These schemes often suggest the establishment of flower strips. Flower strips are a common measure to promote biodiversity and ecosystem service conservation in industrialised countries, since they aesthetically enrich production landscapes and provide supplementary food resources and shelter for natural enemies and pollinators.

We review management options for biological pest control, pollination and cultural services in rice production landscapes and evaluate the parallel development of participatory programmes and mass media campaigns for sustainable rice production. Biological pest control, pollination services and landscape aesthetics could benefit from the establishment of flower strips in rice production landscapes. However, more experimental studies are needed to test the benefits of different plant species, potential interactions between local and landscape scale and interactions between different ecosystem services. Rice farmers should better appreciate their benefits from regulating ecosystem services and should be involved in the development and implementation of ecological engineering. Mass media campaigns and participatory programmes can motivate farmers, but their efficiency needs

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to be tested in different regions. Combining participatory approaches and mass media campaigns with the establishment of flower strips and other beneficial habitats has potential to increase the sustainability of rice production in Asia.

Zusammenfassung

Umfassende partizipatorische Ansätze sind notwendig, um multiple Ökosystemdienstleistungen in Agrarökosystemen auf lokaler und Landschaftsebene zu managen. Dabei sollten alle Interessenvertreter involviert werden. Insbesondere Landwirte sollten an partizipatorischen Trainingsmaßnahmen, Forschungs- und Umsetzungsprojekten mitwirken. Um der starken Intensivierung im Reisanbau entgegenzuwirken, werden Umweltmaßnahmen zum nachhaltigen Management der Reisökosysteme in Südostasien entwickelt (*ecological engineering*). Dabei werden partizipatorische Programme und Kampagnen in Massenmedien mit der Etablierung von Blühstreifen verknüpft. Blühstreifen werden in Industriestaaten häufig als Agrarumweltmaßnahme implementiert, da sie das Landschaftsbild verbessern und zusätzliche Nahrungsressourcen und Schutzräume für Bestäuber und Gegenspieler von Schädlingen bieten.

Wir analysieren die Wirkung von *ecological-engineering*-Maßnahmen auf mehrere Ökosystemdienstleistungen (Bestäubung und natürliche Schädlingskontrolle, Landschaftsbild) in Reisökosystemen. Zudem evaluieren wir partizipatorische Programme und Kampagnen in Massenmedien als Instrumente, um Reisbauern stärker in *ecological-engineering*-Programme einzubinden. Das Landschaftsbild, die natürliche Schädlingskontrolle und die Bestäubungsleistung in Reisökosystemen können durch Blühstreifen verbessert werden. Geeignete Pflanzenarten zur Förderung von Gegenspielern und Bestäubern sollten allerdings noch in experimentellen Studien ausgewählt werden. Zudem sollten mögliche Interaktionen zwischen lokalen und Landschaftseffekten untersucht werden und die Reisbauern bei der Entwicklung von *ecological-engineering*-Programmen mitwirken, um besser ihre Vorteile von den regulierenden Ökosystemdienstleistungen wertschätzen zu können. Partizipatorische Programme und Kampagnen in Massenmedien eignen sich um Reisbauern zu motivieren, an den Programmen teilzunehmen, aber ihre Wirksamkeit muss noch in verschiedenen Regionen getestet werden. Die Kombination von partizipatorischen Programmen und Kampagnen in Massenmedien und die Etablierung von Blühstreifen kann dazu beitragen, dass Reis in Asien zukünftig nachhaltiger produziert wird.

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Introduction

The management of habitats to conserve and enhance multiple ecosystem services in intensified agricultural landscapes needs comprehensive schemes that act across multiple scientific disciplines (Mace, Norris, & Fitter 2012) and spatial scales (Tschamtko, Klein, Kruess, Steffan-Dewenter, & Thies 2005), and involve the main stakeholders (Moreno, Palomo, Escalera, Martin-Lopez, & Montes 2014). To counteract the negative impact of agricultural intensification, in particular the loss of biodiversity and ecosystem services, a more sustainable management of fields and surrounding habitats is required (Godfray & Garnett 2014). Ecological engineering, i.e. the provision of habitats for beneficial arthropods, has recently gained considerable attraction as method to reduce pesticide inputs and enhance biological pest control provided by natural enemies (Gurr et al. 2011). Although the concept of ecological engineering aims primarily at the regulation of pest species through the provision of habitats for their natural enemies (Gurr, Wratten, & Altieri 2004), other ecosystem services, such as pollination and cultural services, might be enhanced with the same measures (Gurr, Wratten, & Luna 2003; Stallman 2011).

Ecological engineering programs commonly suggest the implementation of flower strips (Gurr et al. 2012), which are also popular in agri-environment schemes of industrialised countries (Haaland, Naisbit, & Bersier 2011). Flower strips can enhance pollination and biological pest control services and generally contribute to the conservation of functional biodiversity (Marshall & Moonen 2002). Abundance and species richness of functionally different taxa (e.g. bees, hoverflies, beetles, spiders, parasitoids) can be increased by sown flower strips in agricultural landscapes (e.g. Lavandero, Wratten, Didham, & Gurr 2006; Haaland et al. 2011). In addition, flower strips improve the aesthetics and recreational value of both urban and agricultural environments (Junge, Jacot, Bosshard, & Lindemann-Matthies 2009; Stallman 2011). Many studies have evaluated the beneficial effects of flower strips in industrialised countries (e.g. Marshall & Moonen 2002; Haaland et al. 2011; Tschumi, Albrecht, Entling, & Jacot 2015), but biodiversity-friendly management options for intensive crop production systems in the tropics, such as rice fields, have not been considered in detail.

Rice is the principal staple food for about half of the world's population (FAO 2014b) with a global production of more

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