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Review

Rice and duck, a good combination? Identifying the incentives and triggers for joint rice farming and wild duck conservation

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ABSTRACT

Rice is cultivated in 114 countries worldwide, with nearly half of the world's waterfowl species being directly or indirectly relying on this production during at least one stage of their life cycle. The literature on wild ducks in rice fields is disproportionately represented by studies in North America (although less than 1% of the world's rice fields), while studies in Asia (90% of the worldwide rice production) are mainly focused on the agronomic benefits of breeding farm ducks in Integrated Rice–Duck Farming Systems. In the present literature review we compile knowledge on the interactions between rice farming and ducks, considering positive and negative interactions between the two entities, strategies to alleviate the problems as well as triggers and management options to promote the beneficial relationships. In particular, we focus on (1) the way rice-production areas could be managed in a waterfowl-friendly way, and (2) the agronomic consequences that rice farmers could in return receive from attracting wild ducks or rearing farm ducks in rice fields. For the farmers, the main constraints seem to be associated with duck damages to rice as well as flooding costs. For the ducks, the major issues are habitat loss, homogenization, disturbance and potential disease transmission. However, the present literature review suggests that duck–rice farming is a mutually beneficial association and demonstrates that relatively simple management such as winter flooding can be taken to improve the usability of these habitats to waterfowl, the farmers in turn benefitting from waterfowl ecosystem services.

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1. Introduction

A close relationship exists between bird populations and agricultural landscapes (e.g. Donald et al., 2001; Whelan et al., 2008). In Europe, as much as 30% of observed variation in bird population trends can be explained by fluctuations in cereal production (Donald et al., 2001). While typical farmland birds (e.g. skylark, *Alauda arvensis*) respond readily to changes in their agricultural environment (Chamberlain and Crick, 1999), other species whose associations with farmlands are less obvious can also be impacted. For example, waterfowl (the ducks, geese and swans) are often affected by the transformation of agricultural lands and practices, a common pattern being declines in numbers following the conversion of wet pastures to intensive cereal production (e.g. Duncan et al., 1999). However, the bounty of food made available on such cereal farms is heavily used by some species, especially geese whose populations can increase exponentially (notably *Anser* spp. and *Branta* spp., MacMillan et al., 2004; lesser snow goose *Chen caerulescens,* Gauthier et al., 2005) and some duck species (e.g. cereals in Baldassarre and Bolen, 1984). When considering wet cereal farms, though the conversion of natural wetlands to agricultural lands is inherently damaging to wetland ecosystems, there are often ways to reconcile the differences between the crop's ideal growing conditions and the needs of resident and migratory waterfowl. The focus of this paper is to identify the issues associated with the interaction between the rice industry and wild waterfowl (mainly ducks, both considered as wild and farm birds), and to explore opportunities for ecologically sympathetic ricefield management practices and the incorporation of farm ducks into rice production systems.

Approximately 162 million hectares (1% of the Earth's ice free land surface), or 11% of the world's arable land, is covered by rice fields (FAO-STAT, 2013; Lawler, 2001). Rice is the second most widely grown cereal after wheat, and is cultivated in 114 countries between 50°N and 40°S and up to 2300 m above sea level (Van Nguyen and Ferrero, 2006; Fig. A.1). Rice represents the primary food source for over three billion people, with Asia supplying 90% of global production (Van Nguyen and Ferrero, 2006). Demand for this cereal is expected to continue to grow in coming decades, and production in south Asia alone is predicted to double by 2020 (IRRI, 2000 in Van Nguyen and Ferrero, 2006).

With more than 100,000 distinguishable cultivars, more varieties of rice are grown than of any other crop (Dufumier, 2012). This diversity of cultivars allows rice to be grown in a variety of agro-ecosystems, which can be separated into ten groups based on topography and hydrology, ranging from mangrove swamp rice in tidal zones to hill inland cultivations (see list of such agro-ecosystems in Muzaffar et al., 2010; Wymenga and Zwarts, 2010). Methods of production are also highly variable, and the regime selected is typically determined by freshwater availability and capacity for mechanization. Systems range from traditional low-input to chemically intense, from short (four-month) to long (six-month) growing seasons, from multiple-crop rice-paddy cultivation to slash-and-burn cultivation, and from dry- to deep-water farms (Ibáñez et al., 2010). Chemically intense rice cultivation practices are the norm in North America, Europe, and in parts of Asia, though Asia and also Africa have the majority of the globe's low-input systems. In temperate regions, climatic limitations allow for only a single harvest per year, and fields are typically left fallow during winter months (Ibáñez et al., 2010). In terms of rates of production, the highest volumes of rice come from tropical regions where the climate permits two or even three harvests per year. High rates of production can also be observed on farms that combine rice and animal production, the most common being fish (Halwart and Gupta, 2004), crayfish (Huner, 1994), and ducks (Furuno, 2001), especially in Asia.

Besides farmed ducks, many wild birds also use habitats associated with rice production, including around one third of the bird species found in Japan, Korea, and the Indian subcontinent, and over 20% of the species found in California (Fujioka et al., 2010; Sundar and Subramanya, 2010; Eadie et al., 2008, respectively). Dependency on these habitats varies widely, with some species exhibiting a heavy reliance throughout their life cycle and others using them only temporarily during migration, breeding, or as wintering habitat (Elphick et al., 2010a). Nearly half of the 155 waterfowl species worldwide are directly or indirectly relying on rice production areas (Fig. A.2). This species richness is highest in eastern and central Asia and the continental United States, where important rice-growing regions are located. Although their may be a bias caused by geographic differences in the number of studies, waterfowl species with conservation issues related to rice production seem to be concentrated in eastern Asia, and most waterfowl species in Oceania and Sub-Saharan Africa countries are considered pests by the rice industry (Fig. A.2). Perceptions and acceptance of waterfowl in cultivated areas hence varies by region, depending largely on social and environmental contexts.

Though the globe has lost significant percentages of its natural wetlands over the last century (Finlayson and Davidson, 1999),