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Review

Opportunities and limitations for functional agrobiodiversity in the European context

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ABSTRACT

To counteract the negative effects of intensive agriculture there is increasing interest in approaches that reconcile agricultural production with the conservation and sustainable use of biodiversity and associated ecosystem services. Integration of functional agrobiodiversity (FAB) in agricultural systems holds promise to meet these challenging objectives, but requires the generation, transfer and implementation of tailor-made knowledge, and policy development. Currently various initiatives are undertaken across Europe to develop and assess the potential of biodiversity-based management practices by farmers, industry, researchers and governmental and non-governmental organizations. In this paper we show that the Convention on Biological Diversity and planned reforms in EU policy offer scope to further implement FAB concepts via legislation for biodiversity conservation, pesticide use, water quality, environmental protection and conservation of genetic resources. At the same time we observe that there are still impediments to the adoption of FAB approaches, including (i) translation of general knowledge to tailored, ready-to-use management practices, (ii) limited information on the effectiveness of FAB measures in terms of crop yield and quality, profitability, and reduction of agrochemical inputs, (iii) lack of appropriate financial accounting systems that allow fair accounting of the private investments and public benefits, and (iv) the implementation of FAB measures at the right spatial scales, which requires coordination among the various actors in a region. Current and new legislation may provide incentives to address these limitations and contribute to the further development and integration of FAB concepts in agricultural systems in Europe.

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1. Introduction

While the intensification of agriculture has enabled substantial increases in European food production during the last 50 years, it has also transformed European landscapes and as

such it is considered a major driver of the decline of farmland biodiversity (Donald et al., 2001; Green et al., 2005). Practices such as pesticide and synthetic fertilizer application, the large-scale use of a few high-yielding crop varieties, continued mechanization of agriculture through the use of heavy machinery and removal of (semi-)natural habitats have

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resulted in the simplification of agro-ecosystems at various spatial scales (Benton et al., 2003; Hendrickx et al., 2007). Current European trends are mixed: on the one hand there is increasing intensification and up-scaling in prime agricultural areas, particularly in Eastern Europe, on the other hand there is concern about land abandonment in areas that are considered marginal for agriculture. Both trends can have a negative impact on farmland biodiversity (e.g. Baldock et al., 1996; Verhulst et al., 2004).

There is growing concern that declines in biodiversity affect the delivery of ecosystem services, including those that are essential for agricultural production (Millennium Ecosystem Assessment, 2005). Indeed, pollinators that are vital for the production of many fruits and vegetables show a declining trend in The Netherlands and the UK (Biesmeijer et al., 2006), biological pest control services provided by predators and parasitoids tend to be lower in landscapes that are dominated by crops and have little non-crop habitats (Tscharntke et al., 2005), and soil management associated with intensive conventional agriculture can jeopardize ecosystem services regulated by soil biota, such as nutrient retention and water infiltration (Brussaard et al., 2007) and organic matter cycling (Jongmans et al., 2003).

To counteract the negative effects of intensive agriculture, there is increasing interest in approaches that reconcile agricultural production with the conservation and sustainable use of biodiversity and associated ecosystem services (Scherr and McNeely, 2008; Brussaard et al., 2010). A central concept in this regard is functional agrobiodiversity (FAB), i.e. biodiversity at the scale of agricultural fields or landscapes, which provides ecosystem services that support sustainable agricultural production and can also have a positive spin-off to the regional and global environment and society as a whole (ELN-FAB, 2010). It must be stressed that FAB and biodiversity conservation have different objectives and therefore require different approaches (Kleijn et al., 2011). FAB specifically focuses on organisms and landscape elements that are instrumental in supporting ecosystem services which are relevant for agricultural production, farmer's income, landscape and environment, whereas conservation efforts aim to safeguard the intrinsic value of biodiversity, and typically focus on rare or endangered species. Although synergies between FAB and biodiversity conservation are possible, this will not always be achieved (MacFadyen et al., 2012). The integration of FAB in agro-ecosystems requires understanding of those biodiversity elements that support ecosystem services, and translation of such knowledge into tailored farm and landscape management practices. Such management practices may entail conservation tillage, crop diversification or rotation, as well as informed choices on the integration of non-crop vegetation, such as field margins, hedgerows and woodlots in agricultural landscapes.

Besides the generation of tailor-made knowledge, the development and adoption of FAB measures requires knowledge transfer, implementation of knowledge and policy development, including the design of subsidy programmes (CREM, 2008). As a consequence, involvement from various scientific disciplines and close collaboration between a range of stakeholder groups (e.g. farmers, other land and water managers, private companies, research organizations, nature

conservation organizations and governments) is required. In Europe several FAB initiatives have been taken bottom-up, through multi-stakeholder collaboration. To assess which FAB measures are generally applicable and effective, and which are context-specific, sharing of knowledge and experiences between programmes is essential. Yet, information on these initiatives and the associated practical experience is extremely fragmented and barely accessible. With the development of reforms in EU legislation new opportunities arise for the scaling-up of such FAB initiatives, emphasizing the need to evaluate the effectiveness and opportunities of FAB in a European context.

Historically, environmental policies in the EU have primarily focused on negative impacts of agriculture on biodiversity and ways to alleviate these. More recently, European farmers and policymakers have increasingly recognized that agricultural production and biodiversity need not necessarily be in conflict, but are interdependent and can strengthen each other. Here, we review a selection of FAB initiatives in Europe, and identify future perspectives. More specifically, we first review policies at the EU level that provide scope for implementing and targeting of FAB approaches. Second, we describe a selection of FAB initiatives in Europe, and assess their objectives, approaches and progress. Finally, we identify knowledge gaps and provide suggestions to further improve the potential of FAB in European farmland through scientific and policy support.

2. Links with policy

The integration of FAB in agro-ecosystems aligns well with current and planned international policy instruments. Firstly, at the global scale the United Nations Convention on Biological Diversity contains a Thematic Programme on Agricultural Biodiversity (annexed to decision V/5; <http://www.cbd.int/decision/cop/?id=7147>; 11 October 2012). This Programme recognizes the dilemma of agriculture in that, on the one hand, agriculture may provide essential ecosystem services (such as the production of food and fibre, soil and water conservation, maintenance of soil fertility and biota, and pollination) and, on the other hand, is a major driver of biodiversity loss. In particular those elements in the programme that focus on (i) adaptive management techniques, (ii) practices and policies, and (iii) capacity building, increasing awareness and promoting responsible action can benefit from approaches centred on the conservation and sustainable use of FAB. For instance, FAB practices can be instrumental in conserving and restoring organic carbon in soil and soil structure, conservation and sustainable use of genetic resources, and promoting public awareness of the importance of agricultural biodiversity and its relationship to advancing food security (Brussaard et al., 2010).

Secondly, proposed reforms of the EU Common Agricultural Policy (CAP; Anon., 2010) as per 12 October 2011, which may come into force in 2014, offer opportunities for FAB. At present, the CAP is divided into two main 'pillars', which differ in terms of financing, functioning and structure. Pillar 1 (financed fully from the EU budget) aims to ensure a stable supply of affordable food while ensuring a fair standard of living for the

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