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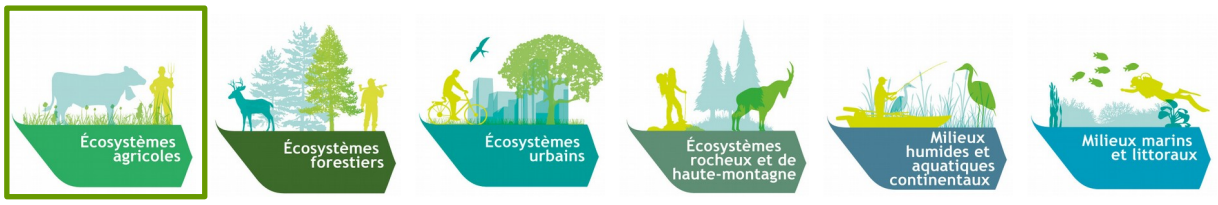
EFESE
L'évaluation française des écosystèmes et des services écosystémiques

Agricultural ecosystems in France

Key messages for decision makers

APRIL 2019



In metropolitan France, agricultural ecosystems cover 54% of the territory (utilised agricultural land), distributed between 62% of arable land, 34% of permanent grasslands and 4% of perennial crops (vineyards and orchards). They include all cultivated or grass plots exploited mainly for agriculture. From a functional point of view, an agricultural ecosystem is made up of the "soil-plant" system of the plots, including the living creatures that circulate there (livestock grazing, wild fauna), and semi-natural elements (hedges, isolated trees, ponds, plot edges, etc.). Due to their specificities and lack of data, oversea agricultural ecosystems could not be assessed here.

This evaluation was conducted as part of the EFESE program by a team led by the Delegation for Collective Scientific Expertise, Foresight and Studies. It has been reviewed by the EFESE Scientific and technical advisory board and the key messages for decision-makers on agricultural ecosystems were discussed and approved on 4 December 2018 by the EFESE National stakeholders committee. The level of consensus observed and cross-references to the detailed sections of the report are presented in the margins of the messages.

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Ecological condition, its evolutions and drivers

1. The evolution of land occupations is linked to that of the production systems, marked since the 1970s by the common agricultural policy, at the origin of a specialization of territories and crop rotation around a limited number of productions[1]. Between 1970 and 2010, this trend is characterized by a decline of permanent grasslands from 41 to 34%[2] and a large expansion of the average size of farms from 19 to 55 hectares[3]. Within cultivated areas, this period is marked by the simplification of crop rotations in relation with the reduction in the number of cultivated species[4].

[1] Well-established and accepted (ref 1, §6)
[2] Well-established and accepted (ref 1, §5.1.1.1)
[3] Well-established and accepted (ref 1, §6 Annexe 2)
[4] Well-established and accepted (ref 1, §5.1.1.2)

2. French agricultural ecosystems host a rich biodiversity which tends to decrease, in diversity and abundance, due to agricultural practices and the simplification of landscape structures[1]. The reduction of (semi-)permanent grassland areas[2], of woody vegetation (hedgerows and tree rows, etc.)[3] and wetlands[4], as well as the use of plant protection products (insecticides, acaricides, herbicides, nematicides, fungicides) synergistically resulted in a sharp decline in biodiversity in cultivated ecosystems, particularly in areas of field crops[5]. This decrease is established for the abundance of birds (a decrease of one third since 1989)[6] but it also concerns, potentially, many other species: insects (decrease of three-quarters since 1989 in German protected areas)[7], bald -moor[8] and soil fauna (earthworms, etc.)[9]. Cultivated biodiversity (number of species and genetic diversity) has also decreased[10], due to the simplification of rotations and varietal selection[11]. Biodiversity has also declined sharply in perennial crops, especially insects, as a result of the increasing use of plant protection products[12].

[1] Well-established and accepted (ref 4, ref 6)
[2,3] Well-established and accepted (ref 7, p. 92-93)
[4] Well-established and accepted (ref 8, chap. 5)
[5] Well-established and accepted (ref 4, ref 6)
[6,7,8] Well-established and accepted (ref 9, p.2-3)
[9] Well-established and accepted (ref 10)
[10,11,12] Well-established and accepted (ref 4)

Male and female Red Partridge (*Alectoris rufa*) on a grassy path (Nouvelle Aquitaine)
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3. The average soil organic carbon content of French agricultural ecosystems[1], as well as their biological activity (bacteria, micro-fauna and earthworms)[2] has decreased in several regions. This is in particular due to the conversions of grasslands from the 1970s to the 1990s and to the decrease in the organic inputs from livestock[3]. This evolution also depends on the region and cultural practices[4].

[1] Well-established and accepted (ref 11, ref 12)
[2] Well-established and accepted (ref 12, ref 13)
[3,4] Well-established and accepted (ref 14)

4. Climate change may strongly affect French agricultural ecosystems[1]. Some effects are already perceptible, such as the modification of the phenology of fruit trees[2], the advancement of harvest dates, particularly harvesting[3] and the more frequent occurrence of long periods of drought[4]. All effects are therefore not yet evident because of the

[1] Well-established and accepted (ref 15, ref 16)
[2,3] Well-established and accepted (ref 17)
[4,5] Well-established and accepted (ref 18)
[6] Well-established

complexity of the combination of factors and the lack of sufficient statistical hindsight[5]. A combination of several climatic events, even if they do not appear exceptional, can for example have very important consequences on crop yields as it has already been the case in 2016 (mild winter and rainy spring)[6].

[5] and accepted (ref 19)

5. By their action on the state of agricultural ecosystems (eg soil organic matter levels)**, certain agricultural practices are levers for maintaining or even promoting the supply of ecosystem services[1].** These levers are the management of pests, tillage, irrigation, soil fertility and all practices that determine the structure and the spatial and temporal diversity of the vegetal cover[2].

[1,2] Well-established and accepted (ref 1, §13.1)

6. To date, the uses of agricultural synthetic inputs are maintained[1] and their negative impacts on biodiversity extend beyond agricultural ecosystems[2]. At the level of all French farms, the average quantities of mineral nitrogen introduced per hectare have been stable for the last two decades[3]. The overall use of pesticides has recently increased, according to the evolution of sales of phytosanitary products[4] as well as the number of treatments carried out[5].

[1,3] Well-established and accepted (ref 1, §6.2.3)
[2] Well-established and accepted (ref 7, p. 64-67)
[4] Well-established and accepted (ref 9, p.3)
[5] Well-established and accepted (ref 20)

Application of fertilizers (Bourgogne-Franche-Comté)
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Ecosystem goods and services, natural heritage

7. As the place of the production of most goods intended for human consumption[1], agricultural ecosystems shelter a biodiversity, animal and vegetal, wild and domestic, which constitutes a heritage[2] and the support of goods and services which benefit the farmers, but also, more broadly, French society as a whole[3].

[1] Well-established and accepted (ref 21)
[2] Well-established and accepted (ref 4, ref 22, ref 23)
[3] Well-established and accepted (ref 2, §1)

8. In agricultural ecosystems, biodiversity contributes in particular to the regulation of cultivation conditions[1]. In particular :

[1] Well-established and accepted (ref 1, §8)
[2] Well-established and accepted (ref 1, §13.1)
[3] Partiellement établi mais accepté (ref 1, §10.1.3)
[4] Well-established and accepted (ref 1, §8.6)
[5] Well-established and

► Plant biodiversity (cultivated cover crops, adventitious flora, semi-natural habitats such as hedgerows and isolated trees) plays a central role in agricultural production because it is a major determinant of all regulatory services[2].

► At present, about 50% of total crop production is attributable to services provided by agricultural ecosystems (supply of nitrogen and return of water to cultivated plants)[3]. Micro-organisms, mesofauna and soil macrofauna (earthworms, etc.) play a direct role in structuring the soil[4] and providing nutrients to the crop[5]. Through their action on certain soil properties (organic matter content, soil structure, etc.), they also determine the soil capacity to store and deliver water to cultivated plants[6].

► The entomofauna and avifauna of cultivated areas play a role, through predation or parasitism, in the regulation of crop pests (eg regulation of aphids by ladybugs and sirphires)[7] and weeds (ex. regulation of weed seeds by carabids, birds, rodents, etc.)[8].

► The diversity and abundance of pollinating insects determines the production of certain crops which depend on insect pollination, such as fruit, vegetable and oilseed crops[9]. Pollination deficit seems to be limiting agricultural production in certain cultivated areas (for example in the Greater Paris Basin)[10]. The value of crop pollination by insects likely exceeds 2 billion euros per year[11].

accepted (ref 1, §8.8, 8.9)
[6] Well-established and accepted (ref 1, §8.8)
[7] Well-established and accepted (ref 1, §8.3)
[8] Well-established and accepted (ref 1, §8.2)
[9] Well-established and accepted (ref 1, §8.1)
[10] Well-established and accepted (ref 1, §8.1.2.2)
[11] Well-established and accepted (ref 1, §8.1.3)

Pommeraie in the « bocage » (Nouvelle Aquitaine).
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9. Relying on regulation ecosystem services, all forms of agriculture that mobilize a lower use of synthetic inputs (agroecology, organic farming, etc.) can better reconcile agricultural production with the preservation of biodiversity[1], water quality[2], the attractiveness of landscapes[3] and the reduction of greenhouse gas emissions from agriculture[4]. The diversity of crop rotations[5], the maintenance and restoration of ecological infrastructures[6] and the reconfiguration of landscape structures[7], can promote the fight against pests or the restoration of pollinators and thus reduce the need for synthetic inputs.

[1, 2, 3, 5, 6, 7] Well-established and accepted (ref 24,25,26)
[4] Partially established but accepted (ref 3)

10. Currently, field-grown ecosystems are not a significant sink for carbon[1]. This average situation masks, however, very different realities, between situations where current dominant practices do not allow to maintain the high carbon stock (resulting in annual carbon destocking), and situations with a low initial stock of carbon that certain cropping systems can maintain or even increase[2]. Storage situations are characterized by

[1,2,3] Well-established and accepted (ref 1, §8.12.2.2)

annual growth rates of the carbon stock mostly below 0.2% and very rarely above 0.3%, ie well below the 0.4% targeted by the "4 for a thousand" initiative[3].

11. Some components of agricultural ecosystems, including grasslands[1], contribute to the regulation of water quality, which can then be used for a variety of uses. This regulation concerns several pollution that are subject to environmental regulation: pesticides, nitrogen, phosphorus and dissolved organic carbon[2]. More indirectly, because of being substitutes for synthetic inputs, certain regulation ecosystem services (such as the supply of nitrogen to cultivated plants) can also contribute to the reduction of associated pollution[3].

[1] Well-established and accepted (ref 27)
[2] Well-established and accepted (ref 1, §8.10 et 8.11 and ref 2, §4.1.1)
[3] Partially established but accepted (ref 1, §8 and ref 2 §2)

12. Some components of agricultural ecosystems can make a significant contribution to flood control and soil erosion control by providing impediments to flow (such as hedgerows)[1] **or by promoting infiltration** (where winter plant cover is present for example)[2]. Soil stabilization and erosion control services are mainly determined by the rate of vegetation cover and the mineral and organic characteristics of soils[3].

[1] Well-established and accepted (ref 28)
[2] Well-established and accepted (ref 1, §8.5, ref 29)
[3] Well-established and accepted (ref 1, §8.5, ref 30)

13. By the arrangement of their plots, the types of crops, the abundance of semi-natural elements and their accessibility in particular, certain agricultural ecosystems can constitute pleasant and attractive landscapes for outdoor recreational activities[1]. The degree of naturalness of agricultural ecosystems is not the only determinant of their recreational potential[2], other characteristics contributing to the attractiveness of certain agricultural landscapes remain to be explored (vineyards, etc.)[3].

[1] Well-established and accepted (ref 1, § 9.1 et 9.2)
[2,3] Well-established and accepted (ref 1, § 9.1)

14. Despite their utilitarian orientation, some agricultural ecosystems have a marked heritage dimension[1]. Because of many past interactions and their strong cultural dimension, certain agricultural landscapes are the object of a strong attachment on the part of the French population[2]. In addition, they comprise many remarkable ecosystems as evidenced by the labeling of the terroirs and multiple signs of recognition of the landscapes they constitute[3] and their agricultural products (*Appellation d'origine contrôlée*, etc.). Finally, agricultural territories host populations of remarquable species, some of which are among the most endangered in France[4].

[1] Well-established and accepted (ref 4)
[2] Well-established and accepted (ref 4)
[3] Well-established and accepted (ref 4)
[4] Well-established and accepted (ref 22, ref 23)

Options for integrated and sustainable management

15. Ecosystem services provided by agricultural ecosystems form clusters in which they are synergistic or antagonistic because they rely on common components of biodiversity[1]. These components include the configuration of managed vegetation cover (cultivated cover, weedy flora and associated semi-natural elements) and the abundance and diversity of associated animal biodiversity (crop aids, micro-organisms and soil fauna)[2]. The level of soil organic matter also plays a key role that can generate many positive effects in synergy[3].

[1,2,3] Well-established and accepted (ref 1, § 13.1)

16. At the local scale, the evaluation of bundles of ecosystem services is necessary but not sufficient to promote multifunctional ecosystem management strategies taking into account the diversity of users[1]. Such strategies should be based more broadly on a multi-criteria assessment integrating multiple management issues, namely:[2]

1. the capacity of ecosystems to meet the needs of present and future generations;
2. the conservation of biodiversity for itself;
3. the reduction of the environmental impacts of agricultural activities.

In addition, such an assessment should integrate the main functional relationships with other ecosystems, including with ecosystems downstream of watersheds.

[1] Well-established and accepted (ref 1, § 12 et ref 2, §6.1)
[2] Well-established and accepted (ref 2, §6.3)

Knowledge and data gaps and needs for further studies

17. Further studies and the acquisition of data and knowledge are needed to strengthen a multifunctional and integrated management of agricultural ecosystems[1]. The provision of certain services by agricultural ecosystems, such as the regulation of crop and livestock diseases, remains speculative in the absence of a comprehensive study[2]. In addition, the understanding of the quantitative relationships between the level of service delivery, the practices and arrangements of agricultural landscapes and the biophysical characteristics of ecosystems often remains very limited (eg between pest control service, phytosanitary practices, abundance of auxiliaries crops and yield)[3]. Knowledge on the effects of agricultural practices on soil quality depends on national monitoring systems such as the Soil Quality Measurement Network[4]. Since agriculture depends on services provided by soils and their biodiversity, this knowledge is essential for developing a sustainable agriculture[5]. These shortcomings also make it difficult to assess services in monetary terms[6].

[1,2,3,5,6] Well-established and accepted (ref 2, final section)
[4] Partially established but accepted (ref 10)

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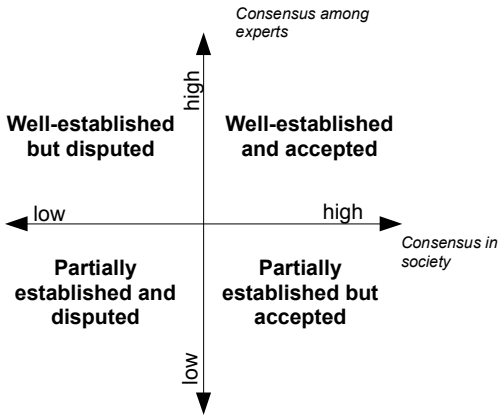
The key messages for decision makers

The key messages for decision-makers are co-written by the EFESE project team of the Ministry for an Ecological and solidarity transition and by the authors of the studies. In order to enhance their scientific credibility and their legitimacy in the eyes of decision-makers, they are subject to scientific advice and stakeholder approval.

Every assertion composing these messages is qualified on two dimensions. The **scientific consensus**, first, is informed on two levels. It is proposed by the authors of the study and submitted to an arbitration by the EFESE Scientific and technical advisory board. The **societal consensus**, on the other hand, is informed on two levels. Unless opposition is expressed, the level of consensus is considered high. It is degraded as soon as a stakeholder disputes the assertion and makes the reasons for its disagreement explicit. This gives rise to the four qualifications which are presented opposite and indicated in the margin of the messages.



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