

Modernisation of EAA – Measurement of the economic value of public goods produced by the agricultural sector

2022 edition



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Abbreviations

CAP	Common Agriculture Policy
DG Agri	Directorate-General for Agriculture and Rural Development
EAA	Economic Accounts for Agriculture
ECA	European Court of Auditors
ESA	European System of Accounts
EU	Europe
ESTAT	European Statistical Office
FADN	Farm Accountancy Data Network
GDP	Gross Domestic Product
MS	Member States
NPI	Non-profit Institutions (NPI)
OECD	Organisation for Economic Co-operation and Development
PG	Public Goods
SDTT	Standard data transmission table
SEEA	System on Environmental Accounting
TEV	Total Economic Values
TOR	Terms of Reference
UN	United Nation
WTP	Willingness to Pay
WTA	Willingness to Accept

1

Introduction

The Economic accounts for agriculture (EAA) are satellite accounts providing complementary information and concepts adapted to the particular nature of the agricultural industry. Although their structure very closely matches that of the national accounts, their compilation requires the formulation of appropriate rules and methods.

Agricultural accounts are a basic tool for **analysing the economic situation of a country's agriculture, provided that they are drawn up on the basis of a single set of principles** and also if they make a valuable contribution to the calculation of the national accounts.

The EAA consist of a production account, a generation of income account, an entrepreneurial income account and a capital account for agricultural production. The production account contains an elaborate breakdown showing output for a range of agricultural products, as well as non-agricultural secondary activities; substantial detail is also presented for intermediate consumption and capital formation.

The main purpose of the EAA is to analyse the production process and the primary income generated by it. The accounts are therefore based on the industry concept.

In 2015, the European Court of Auditors (ECA) carried out an audit on the European Commission (DG AGRI and ESTAT), on farmers' income entitled: "Is the Commission's system for performance measurement in relation to farmers' incomes well designed and based on sound data?" DG AGRI was the principal auditee but ESTAT was also audited. The audit report (Special Report No 1/2016) was issued on 7 April 2016 ⁽¹⁾.

ECA report refers to economic accounts for agriculture (EAA) and the farm accountancy data network (FADN) as the main tools currently available at EU level for measuring farmers' incomes.

Key findings of the ECA report on farmers' income with regard to the issue of developing the EAAs and improving coverage related to public goods (PG) were as follows:

"The EAAs are the Commission's main statistical source for monitoring farmers' incomes globally at macroeconomic level. However, their potential has not yet been fully used and they are not sufficiently informative about important factors that are relevant for farmers' incomes, as well as for the economic value of agriculture as a whole. The FADN is an important instrument for the evaluation of the CAP but it has limitations, because it covers only commercial holdings and income information is incomplete".

"By definition, the EAAs measure, at the macroeconomic level, economic performance and growth as a result of market activities and their evolution over time. They do not account for public goods provided by farmers to society. The provision of such public goods is an important specific objective of measures such as the 'greening payment', which accounts for 30 % of the EU direct payments. It emphasises the multifunctional role of agriculture, while also contributing to the income of farmers. The extent to which agriculture produces public goods and its evaluation by society may, however, vary significantly across regions and Member States.

(1) ECA Special Report No 1/2016. Is the Commission's system for performance measurement in relation to farmers' incomes well designed and based on sound data?

So far, the Commission has not considered developing the EAAs further or established any other instrument to measure the economic value of public goods produced by the agricultural sector as a whole."

ECA recommended that the Commission should examine whether the EAAs can be further developed to provide a reasonable estimate of the economic value of the public goods that are produced by farmers..."

There is no formal definition of public goods in the current Common Agriculture Policy (CAP). From the experts' consultation with DG AGRI it was ascertained that DG AGRI was of the view that the value of public goods produced by agriculture is more than the market value for related agricultural activities and that this value could be expressed either as cost of production or as value for society. Both options for valuation should be considered for future investigation.

In the Explanatory Memorandum for the proposal for a direct payment regulation in 2011, there is a reference made to public goods: *"At the same time, agriculture and rural areas are being called upon to step up their efforts to meet the ambitious climate and energy targets and biodiversity strategy that are part of the Europe 2020 agenda. Farmers, who are together with foresters the main land managers, will need to be supported in adopting and maintaining farming systems and practices that are particularly favourable to environmental and climate objectives because market prices do not reflect the provision of such public goods. It will also be essential to best harness the diverse potential of rural areas and thus contribute to inclusive growth and cohesion."*

Objective of the study and actions taken

The main objective of the study as described in the Terms of reference (ToR) is to ascertain if and in how far EAA are an appropriate means to show the value of public goods. In particular, the study should cover the feasibility of reasonable estimates of the economic value of public goods in the EAA. Public goods produced by farmers, in this context, could include but not necessarily be restricted to rural landscape, farmland biodiversity, water availability and quality, air quality, soil functionality, climate stability, resilience to flooding, landslide and wild fire, rural viability/vitality and cultural heritage, food, energy and timber security and quality, farm animal health /welfare, etc. Consideration should be given that some of these are rather ecosystem services (as described in the UN SEEA EEA) produced by farmers.

Using the information provided by Eurostat and other relevant documentation (e.g. feasibility report 2013 by JRC, interim reports of PROVIDE, PEGASUS), the contractor should produce a report that will include among other things:

- A clear definition of public goods produced by farmers, including a consolidation of the available information and a classification of types of public goods, for the purpose of the study;
- A hierarchy of definitions should be produced;
- An analysis of the stage of development in the consulted Member States, with regard to their ability to value public goods in agriculture, assessing the diversity of approaches and challenges faced and solutions found, including with respect to eventual EAA inclusion;
- An assessment on whether source data for public goods in EAA, in general, exist and what these are. If they do not exist, what are the challenges to be faced in obtaining suitable data?
- An assessment of if and how the value of public goods is already recorded in EAA by the consulted Member States (e.g. if not treated as economic value, then are the costs of maintaining public goods included under intermediate consumption, investment or elsewhere? Are these identifiable? Are subsidies linked to public goods identifiable?);
- An analysis of whether EAA as satellite accounts are really a suitable vehicle to measure public goods and if not, suggesting other alternatives (e.g. environmental statistics/environmental accounts or separate specific indicators);
- Assuming EAA are an appropriate way to show the value of public goods, whether a cost approach or a total economic value or other methods would be more suitable and acceptable e.g. are estimates of value appropriate for EAA under the rules and practices governing national accounts?); a definition

of each approach should be provided, showing to which ESA categories the values would be shown (output, intermediate consumption, investment, etc.);

- A proposal of what would be the most suitable way for Member States to collect the data (e.g. FADN, FSS, etc.), considering the benefits of having coherent and comparable data sets at European level;
- A summary of any issues, observations, practices and conclusions that the contractor may draw in the course of this work that would assist Eurostat and the AAP WG members in their discussions on whether EAA are suitable for capturing the value of public goods.

In this context, the following actions were undertaken by the project experts:

Action	Outcome
1. Review the existing information related to public goods produced by farmers.	<ul style="list-style-type: none"> • The outcome of the actions represents the core part of the study as a summary of the existing researches and information related to public goods produced by farmers is made.
2. Exchange of view as regards the existing information on public goods and current and possible inclusion in EAA with seven (selected) MS	<ul style="list-style-type: none"> • Information relate to the current situation in the selected MS.
3. Based on the outcome of action 1 and 2 above an investigation of the public goods related information existing in EAA or possible inclusion of it into EAA.	<ul style="list-style-type: none"> • An assessment based on the EAA structure and methodology; • Drawing conclusions and recommendations.

2

Study case on seven Member States

This chapter includes an analysis of the stage of development in Member States with regard to their ability to value public goods in agriculture, assessing the diversity of approaches and challenges faced and solutions identified, including with respect to eventual inclusion of public goods valuation into EAA.

In this context, a short questionnaire related to the public goods from agriculture was prepared. The agreed questionnaire was sent to the experts working on the EAA in seven selected countries: DE, IT, LU, PT, SI, UK and CH. All the countries have been supportive and answered the questions.

The questionnaire had a three-fold purpose:

- Analysis of the stage of development regarding the valuation of public goods in agriculture;
- Assessment approaches and challenges faced;
- Views on the eventual inclusion of Public goods from agriculture in EAA.

2.1. Summary of the information collected

This section is briefly summarising the feedback received from the seven Member States (DE, IT, LU, PT, SI, UK and CH)

Table 1: Summary of the information received

Question	Summary
1. Do you have a national definition/classification of public goods in your country? (If yes, please provide it to us)	<ul style="list-style-type: none">• None of the countries supporting the development of the study (DE, IT, LU, PT, SI, UK and CH) have a national definition, classification or concept of "public goods from agriculture".
2. Do you have a national definition/classification of public goods in your country? (If yes, please provide it to us)	<ul style="list-style-type: none">• No costs included in the EAA - DE, SI, UK;• Production costs for the upbringing of public goods are included (totally or partially) in the EAA- IT, PT, CH;• Not clear – LU
3. Do you consider that the information on subsidies provided to farmers in your country (e.g. greening, environment and climate, ecological agriculture) could be a source of information that could be used for the identification of specific activities/ costs for the production of public goods at a farm level? Please explain your answer.	<ul style="list-style-type: none">• This information could help to identify specific activities and related costs –IT, SI, UK, CH• Will not be possible to identify the specific activities/costs of production of public goods –DE, PT, LU

Question	Summary
<p>4. Do you have any views on the measurement of the value of public goods produced by farmers in your country? Are the EAA an appropriate means to show the value of public goods or are there some other more appropriate means?</p>	<ul style="list-style-type: none"> • DE - Whenever the agricultural accounts are modified, it should be noted that the calculation is retained as a satellite account of the national accounts. The evaluation of the services of the public goods would then take place within the framework of a sectoral calculation. Inputs to sector accounting would be the data from the EAA (as a satellite account) and other statistical sources, some of which need to be redeveloped. • PT- EAA is not an appropriate means to measure the value of public goods in agriculture. • UK - EAA cannot provide much relevant data. Most of the societal costs and benefits have no market value and hence must be specifically estimated using studies such as "willingness to pay" methods. • CH - don't think we will be able to make a complete valuation of public goods in EAA (and bridge with NA), as some public goods will remain outside the production boundary as defined by SNA / ESA. • LU- In the absence of objective data on the production of public goods at a sector level, the EAA are not an appropriate means to show the value of public goods.

2.2. Experts considerations

As a general remark, it can be underlined that the consideration on the information related to public goods produced by farmers and the link with EAA is, in all the countries approached, in a very incipient phase.

- None of the investigated countries has a national definition, classification or concept of public goods. Due to lack of harmonised definition, they are unable to make an exhaustive list of public goods produced within their territory, and consequently to measure their quantity and value.
- At this stage, the countries have different views related to whether the costs related to Public Goods are included or not in the accounts. Italy gives a detailed list of EAA items, which includes information related to Public Goods (codes in production side including secondary activities, intermediate consumption and others).
- The experts from all the countries investigated agreed that the information on subsidies can be a good source of data. It can help to identify both the actors (beneficiaries) and the activities related to the production of public goods at farm level. However, without additional activities (surveys, researches), this information is surely not enough to deal with the subject in depth in the EAA. As an initial step, it would be necessary to aggregate all subsidies at the European level as well as defining an agreed list of Public Goods categories. Then this should be completed with the national measures. A methodology should be prepared to calculate the costs associated to public goods provision, selecting specific subsidies received by farmers. The module of the European Environmental Economic Accounts, namely the Environmental Protection Expenditure Accounts of farmers may be a solution/proxy for this calculation. The main limitation of this approach is related to the calculation of specific costs for public goods provision due to issue of jointness (see chapter 2). Anyway, some types of subsidies (e.g. agri-environmental schemes) could be a good starting point to calculate additional costs and income foregone for farmers that introduce farming practices that increase the provision of public goods (further details in next chapter).
- As EAA are satellite accounts of National Accounts and the main purpose of the EAA is to analyse the production process and primary income generated by it, EAA have to comply with the concepts,

definitions and rules laid down in the ESA. Since providing some of the public goods will remain outside the production boundary as defined by SNA / ESA, making a complete valuation of public goods in EAA (and bridge table with NA) is not a suitable solution.

- ESA (System of National Accounts) 2010 does not have any direct reference on public goods. However, several references related to public goods as collective services, e.g. in 4.119: 'in the case of most collective services, or so-called "public goods". Later (23.11 b.) public goods are mentioned in relation to Non-profit Institutions (NPI) as they may produce public goods, but their role is strictly defined against the Government (23.11 h.) 'Although they provide public goods and services, they do not have the same powers or restrictions as government in deciding what these goods and services should be and how they should be allocated.' At National Accounts level, Goods and Services are evaluated only in the way they generate economic value, being available for intermediate consumption, final consumption, investment or exports. The concept that in any specific way may be related to the creation of public goods is "collective services" (ESA 2010 §3.102), generated by General Government and correspondent to collective consumption, which is evaluated through costs.

3

Public goods - produced by farmers

3.1. Definition

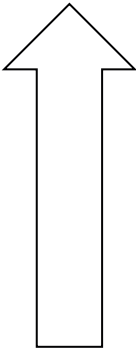
According to the definition of Samuelson (1954), the main characteristics of public goods are the non-excludability and the non-rivalry. A good is public if it is available to one person and others cannot be excluded from the benefits it confers (non-excludable); at the same time, if such good is consumed by one person it does not reduce the amount available to others (non-rival). These characteristics imply that users have no incentive to pay for the consumption of such goods and, on the supply side, there are no incentives for providing public goods, because potential producers are not remunerated by the market to do so. The combination of these factors explains the so-called 'market failure', and the reason for the need of public intervention in order to achieve a socially optimal level of public goods, consistent with societal demand.

The reasons beyond the so-called market failure are related to the characteristics of non-excludability and non-rivalry, which determine both the lack of incentives to produce public goods and the presence of opportunistic behaviours (free riding). The efficiency of market mechanisms regarding the allocation of goods is mainly related to the characteristic of non-excludability, since market mechanisms work better for goods with high-excludability levels (Merlo et al. 1999). At the same time, goods with a low-excludability level present several problems related to congestion and over-exploitation, as described in the 'Tragedy of Commons' (Hardin 1968).

By using the concepts of non-rivalry and exclusion, it is possible to show that there are intermediate forms between pure public goods and private goods. Common goods or common pool resources are the goods where rivalry exists, but exclusion is not possible (e.g. common fish grounds or water systems) and quasi-public goods are the goods (also called club goods or toll goods) where exclusion is possible, but rivalry does not exist unless users reach certain thresholds (table 2). The concept of non-rivalry leads to other important considerations, related to the production function. Production function, cost function and marginal cost appear to be difficult to implement. In the short term, marginal cost is often close to zero that means that the supply of an additional unit of the public good doesn't imply a higher production cost. This is the case of goods for which the producer bears the total producing cost by supplying indeed the first unit of the good. Cultural heritage protection, water protection schemes, etc. often show similar characteristics.

As showed by Cooper et al. (2009), in reality, the characteristics of non-excludability and non-rivalry may be exhibited to almost any degree, and indeed pure public goods are rare. This is because sometimes it exists some potential to exclude - often at considerable cost - people who do not contribute to covering the costs associated with the provision of a particular public good, and specific public goods, such as popular cultural landscapes, can become congested, leading to a loss of enjoyment. As such, any given public good can be situated along what may be described as a continuum of 'publicness'.

Table 2: Classification of goods according their level of publicness

Level of 'publicness'	Type of good	Excludability and rivalry	Examples
	Pure public goods	Non-rival Non-excludable	Biodiversity Non-use values of landscape
	Impure public goods (Common Pool Resources)	Non-rival Excludable only at high costs (high risk of congestion)	Public access to farmland Ground and surface water Soil conservation
	Club goods	Non-rival for a small user group Excludable (subject to congestion)	Private parks Golf course
	Private goods	Rival Excludable	Wheat, timber

Source: Elaborations on Cooper et al. (2009) and OECD (2001).

During the last decade, the provision of public goods through agriculture has been explored in depth in several publications (see, for example Cooper et al, 2009; OECD, 2013 and 2015; Santos et al., 2016) and in several EU research projects (e.g. H2020 PROVIDE ⁽²⁾ and H2020 PEGASUS ⁽³⁾). These studies identified a wide range of environmental and other public goods that can be provided through appropriate agricultural practices, many of which are highly valued by society, for example cultural landscapes, farmland biodiversity, good quality water, well-functioning soils, rural vitality, animal welfare and aspects of food security (see section 3.2 for a more detailed classification).

It is important to underline that agriculture can have both positive and negative impacts on public goods. These negative or positive effects are defined as externalities, which may also have the characteristics of non-rivalry and non-excludability (OECD, 2013; 2015). When goods satisfy the two criteria of being non-excludable and non-rival, they are defined as public goods. Thus, the externalities associated to agriculture can be classified into the four types of goods listed in table 2: pure public goods, impure public goods (Common Pool Resources), club goods and private goods, depending on the degree of non-rivalry and non-excludability. Detailed definitions of externalities and of the different typologies of goods are provided in table 3, together with some examples related to the agricultural sector.

Table 3: Definitions of different types of goods and agricultural examples

Type of good	Definition	Agricultural examples
Externalities	Externalities occur when decisions about production or consumption by one person affect someone else without this being considered by the decision maker. If one person's action has a positive impact on another, the externality is defined as positive. When the externality decreases the well-being or utility of the affected person, it is defined as a negative externality. A typical example of a negative externality is pollution.	An example of a positive externality is the grazing of animals on pasture. Many people enjoy seeing these animals and consider that they enhance the agricultural landscape. Agriculture may produce negative externalities such as water pollution and soil erosion as a result of the use of fertilisers and pesticides, or unsustainable farming methods.

⁽²⁾ PEGASUS - Public Ecosystem Goods and Services from land management – Unlocking the Synergies. <http://pegasus.ieep.eu/>

⁽³⁾ PROVIDE - PROViding smart DELivery of public goods by EU agriculture and forestry. <http://www.provide-project.eu/>

3 Public goods - produced by farmers

Type of good	Definition	Agricultural examples
Pure public goods	Pure public goods are goods that satisfy the two criteria of being non-excludable and non-rival. In reality, these characteristics of non-excludability and non-rivalry may be exhibited to almost any degree, and indeed pure public goods are rare. The provision of pure public goods poses a free rider problem: providers of pure public goods cannot exclude anyone who tries to enjoy the benefits without paying for them, thus making it difficult for individuals to provide pure public goods on a commercial basis.	A stable climate is one of the purest public goods as the benefits are universal. Whilst the farming sector is a net contributor of greenhouse gas emissions, a range of agricultural practices can promote carbon storage and then contributing to climate stability. Biodiversity and landscape are other examples of pure public goods.
Impure public goods (Common Pool Resources)	Common Pool Resources (CPRs) are goods which are rival (subtractable) but for which it is difficult to exclude someone from consuming them. This leads to a risk of overexploitation.	A shared pasture would be depleted if each herder put a maximum number of cows on the land. In this case, to prevent this over-exploitation, community or governmental rules to successfully regulate this CPR would have to be enforced. If property rights are successfully established and are exclusive to members, CPRs could be treated as a club good. Other examples of CPR are: water quality at hydraulic basin level; soil erosion by flooding control and maintenance of drainage networks, fire protection.
Club goods	Club goods are impure public goods since non-members are excluded from consuming them. In contrast, members may consume the goods without rivalry, unless there is a risk of overcrowding or deterioration of the good.	An example of a club good is the protection of wildlife on a certain tract of land, or of fish stocks in a watercourse, paid for by syndicates of hunters who have exclusive hunting rights in the areas concerned, and prevent others from enjoying the wildlife, either for hunting or simply for the pleasure of observing it. In this case, governments could play a role. A national park can also be an example of a club good if people are required to pay an entrance fee for recreational purposes and enjoying other public goods (landscape, biodiversity, etc.).
Private goods	Private goods are goods that are excludable and rival. For private goods, prices tell market participants how valuable one good is, and prices tell producers how much they should produce to maximise their benefits.	Agricultural products such as food and fibre but also diversification activities (i.e. agro-tourism, green care, energy production, traditional cultural events, typical products exhibitions, etc.) that are remunerated by the market.
Public bads	Public goods need not necessarily be desirable; that is, they may cause harm. If non-rival and non-excludable goods cause harm and people do not want them, the term, public bads, may be used. In this case, non-excludability means it is impossible to exclude anyone from avoiding the consumption of the bad, and non-rivalry means the same bad can be consumed by anyone without diminishing the consumption opportunities available to others.	Agriculture produces agri-environmental public bads and reducing the supply of agri-environmental public bads so as to correspond to the socially demanded level is an important policy challenge. Indeed, an environmental benefit (or harm) has to be viewed as relative to a certain environmental level, and this environmental level can vary depending on the country and the local situation.

Source: Elaborations on Cooper et al. (2009) and OECD (2015).

Before identifying and classifying the main public goods associated to agriculture, it is necessary to highlight the importance of the spatial and temporal scales. Local scale is usually needed when assessing the relations between farming and some public goods such as soil, water and air quality, which can be considered local public goods. On the opposite, goods such as biodiversity and climate stability have been usually considered global public goods. A review of environmental case studies and a classification according to the scale (local, landscape/watershed, regional, or global levels) was provided by Kerkhof et al. (2010), who showed that the majority of studies are related to the local and landscape/watershed levels, but that the number of cases at the regional and global levels has been increasing.

It is relevant to emphasise in the context of the present study that relations between local and global public goods (and public bads) are quite complex. It may be argued that for local public goods it is usually easier to identify producers and consumers as well as developing solutions to overcome market failures through negotiations between them. On the opposite, direct negotiations are more difficult for global public goods such as greenhouse gas emission and carbon sequestration (OECD, 2015). At the same time, some public goods that are produced and consumed at the local level have also implications at regional and global scales when aggregated, e.g. agricultural landscapes contribute to society's well-being through local recreational activities and to climate stability through carbon sequestration (Novo et al., 2017). In addition, people might perceive and attach different values to public goods and bads, depending on the scale of provision and on the historical period considered, for this reason a key element is whether both supply and demand of different types of public goods match across time and space.

Another important issue to be considered regarding the time scale is the long period of time that usually intervenes between the action undertaken by farmers and land managers and the effect that can be found on the public good (for example the effect on quality deriving from more suitable farming practices can be measured only after several years, due to the complex ecosystem and biological dynamics regulating the water scale at basin level).

Before identifying the main agri-environmental public goods associated to agriculture that are relevant in the context of this study, it is necessary to outline that agriculture also produces agri-environmental public bads. Public bads are non-rival and non-excludable goods that may cause harm to people and to the environment. The reduction of supply of agri-environmental bads so as to correspond to the socially demanded level is an important policy challenge.

Examples of public bads are provided by EFTEC (2004) and are related to negative effects on water (consumption, pollution increase due to chemicals residuals, flood resilience depletion), on air (production of dust, allergens and pollution due to increased presence of chemicals residuals) and on soil (fertility loss, erosion). Farming may also have negative effects on landscape (land consolidation, reshape of land plots or hilly slopes, intensive agricultural activities, greenhouses), biodiversity (loss of biodiversity, use of few species on a large scale, etc.), waste production (waste production of different kinds, their management and disposal) and more in general may involve the depletion of non-renewable resources as well as having negative effects on human health (effect of chemical contaminants in water, air and food).

Similar to the assessment of public goods, also the assessment of public bads should consider the issues of spatial and temporal scales. It is easy to assess that many of the cited factors affect local public goods, while others have a wider impact. Moreover, when looking at the relations between agriculture and public goods from an accountability perspective, public "bads" should be evaluated beside "goods". This increases the difficulties of having an overall assessment of the relations between farming and environmental public goods.

Market prices, defined by the traditional equilibrium between supply and demand, are based on private individuals' choices. In case of public and semi-public goods, however, private demand and supply are not able to adjust the equilibrium considering the individuals' behaviours that benefit from public goods but are not asked to pay the specific amount of money related to the higher utility level they achieve. This is why market prices do not reflect the real social value of all produced and consumed goods, and free-rider behaviour occurs.

The evidence comes from the so-called externalities. Pearce (et al. 2003) defines externalities as the "non-voluntary side effects of ordinary goods production and consumption, that affects others' behaviour in a positive/negative way". Public goods and externalities enter good production and consumption dynamics; however, actors' behaviour will not be driven by exchange prices since for such goods a market simply does not exist. In other words, externalities can be seen as an interference, caused by an individual involved in ordinary economic activities, to other's utility function without the occurrence of an economic transaction between them (economic compensation). The only way of reaching an optimal equilibrium (based on marginal cost/prices) relies on the possibility of including social costs in the production side (supply curve).

3.2. Classification

An initial classification of the public goods associated to agriculture was provided by Cooper et al. (2009), who highlighted the distinction between environmental and social public goods. The most significant environmental public goods identified - although with different level of publicness - were agricultural landscapes, farmland biodiversity, water quality, water, availability, soil functionality, climate stability (greenhouse gas emissions), climate stability (carbon storage), air quality, resilience to flooding and fire, while the social public goods included were food security, rural vitality and farm animal welfare and health.

More recent studies have focused specifically on the provision of agri-environmental public goods (OECD, 2013, 2015; Santos et al., 2016), while other studies (Hart et al., 2011; Dwyer et al. 2015) included some 'functions' and 'services', which are more related to the socio-political notion of public goods.

The present report will focus only on the environmental public goods associated to farming for the following reasons:

- Functions and services such as rural vitality and food security can be considered as socially shared values about desired states of being, but this does not make them public goods in *stricto sensu*: they are societal aspirations and, if achieved, they represent only socially and politically outcomes (Novo et al., 2017).
- These states of being and/or political desiderata can be reached only through complex interactions of public and private goods (and potentially also club goods and common pool resources). For example, to provide food security, private goods are needed (food, transport), products can be derived from Common Pool resources (e.g. fisheries or water) and public goods (e.g. farmland biodiversity).
- The provision of socio-political goods is not only the result of production functions at the farm level, but is the result of the combination of different types of goods with other elements such as institutions, capabilities and power relations. Although this could be the case also for environmental goods, it is particularly true for complex and multidimensional goods such as rural vitality and food security.
- Due to the multidimensional status of such goods, it is very difficult (and in some cases not possible) to identify and measure the relations between them and agriculture at farm level.
- The most recent studies on the topic provide a quite comprehensive list of environmental public goods associated to farming, which have different levels of 'publicness' and also different spatial and temporal dynamics. Table 4 provides an exhaustive list of public goods that could be considered also for the purpose of present study.

Table 4: The main environmental public goods associated to farming, with related services and benefits

Public goods	Description
Landscape	The role of landscape in providing cultural services and benefits: Aesthetical, Health, Cultural, Identity, Heritage, Educational, Inspirational, Spiritual, Religious Leisure, recreational and tourism services. The landscape itself (good/goods) Sense of place
Biodiversity	Ecosystems and habitats assemblage and network (ecological infrastructure) that support the functional diversity (ecosystems and habitats functions) Ecosystems and habitats diversity Landscape features related to land use, examples: arable land, woodland, Rough grazing, Hay meadow, semi-natural grassland Genetic and species diversity Umbrella species, flagship species, endangered species, rare species, charismatic species, familiar species, locally important species, endemic species, autochthonous breeds

Public goods	Description
Water quality and Water availability	Services provided by water availability and quality: Drinking water, bathing water and other recreational uses (e.g. angling, boating), Water for agricultural uses (irrigation, livestock), and for other uses (domestic, industrial). Water quality and availability are intermediate services for: biodiversity, landscape quality (cultural services) and soil quality
Soil quality	Services provided by soil quality: Soil fertility and productivity, carbon storage (climate stability) Soil quality is an intermediate (supporting) service for: biodiversity, landscape quality (cultural services), water quality, air quality, resilience to fire and flooding
Air quality	Services provided by air quality: Clean air, visibility Benefits provided by air quality: life quality, human health, biodiversity Air quality is an intermediate service for: biodiversity, climate stability, water quality
Climate stability	Services provided by climate stability: Carbon offset, climate stability Benefits provided by climate stability: life quality, human health, biodiversity and landscape quality, hazard prevention (wildfires and flooding)
Resilience to fire	Services provided by fire resilience: wildfires prevention; mitigation of wildfires effects Benefits provided by fire resilience: secure property, prevent human lives loss, landscape maintenance, biodiversity preservation, soil quality, water quality and availability, climate stability, resilience to flooding (related to soil quality and ecosystem water regulation functions)
Resilience to flooding	Services provided by flooding resilience: prevention of flooding; mitigation of flooding effects Benefits provided by flooding resilience: secure property, prevent human lives loss, landscape maintenance, biodiversity preservation, soil quality, water quality and availability

Source: Madureira et al. (2013).

In order to analyse and estimate the public goods listed above, it is possible to distinguish two main theoretical and analytical approaches: supply side and demand side.

The supply-side approach is well synthesised by the definition of multifunctionality of agriculture provided by the OECD (2001), which defines multifunctionality as ‘the existence of multiple commodity and non-commodity outputs that are jointly produced by agriculture and the fact that some of the non-commodity outputs exhibit the characteristics of externalities or public goods, with the result that markets for these goods do not exist or function poorly’. This definition includes the core elements for understanding the relation between the agricultural activities and public goods provision from a supply side perspective, both in terms of theoretical development and in terms of policy definition. Indeed, this approach conceptualises public good provision in terms of joint outputs of an activity or of a combination of activities. Certain public goods may be provided incidentally as a side-effect of economically viable activities, or as a result of farmer self-interest or altruism. The level of jointness of different public goods with agriculture practices is very complex and is usually characterized by high variability across areas, countries and specific environmental and social goods (OECD, 2008). As it will be discussed later, the challenge of understating the level of jointness between private and public goods is not only at the core of this approach, but is also very relevant in the context of the present study, since the concept of jointness involves important implications on the mechanisms of public goods provision as well as on their evaluation. As it will be further discussed, when looking at the supply side of agri-environmental public goods, one way to examine the scale of supply is to use agri-environmental indicators (Cooper et al., 2009; Hart et al., 2011).

The second theoretical and analytical approach, the demand-side approach looks at the provision of public goods through agriculture both as a societal objective and as a demand of society for the multiple functions of agriculture. This approach involves a different vision regarding the relation between farming and public goods, more territorially embedded being more related to rural areas rather than to specific farming practices. Indeed, according to this approach, agriculture should satisfy societal expectations and meet societal demand and needs not only in relation to the production choice, but it should satisfy the new needs and preferences of the society at large. In the demand-side approach, the characteristics of non-rivalry and non-excludability of goods are straightened by the

'non-user values' or 'option values', which reflect the interests of citizens in securing the provision of public goods, such as habitat preservation or the protection of endangered species, and who is willing to bear the costs, even though they are not immediate users and the goods concerned may be a long distance from them (ENRD 2010).

Even if ordinary market transactions do not include public goods and externalities (as monetary amount involved in the exchange between supply and demand), however, it does not mean they are not economic goods, as clearly shown by their scarcity, by the utility provided, and by the demand that consumers explicitly reveal. Accordingly, a different concept of value is taken into account, referring to the demand side and being based on welfare economics.

This is the reason why when implementing valuation assessments, it is necessary to measure welfare changes caused by a variation in the public good quantity (or other characteristics). Welfare changes can be measured referring both to supply side and demand side. The former refers to farmers, landowners and other provider (costs for improving the public good provision), while the latter refers to beneficiaries (social benefit derived from the public good increased availability).

These two different approaches (supply side and demand side) imply also different types of valuation assessments, which will be discussed in greater details in next sections. Whereas supply side valuation assessments focus on the costs for farmers to produce public goods (section 3.3), demand side valuation assessments focus on the population which mostly enjoy benefits derived by the provision of public goods. As it will be further discussed in section 3.4, this approach is usually characterised by economic analyses which aim at assessing the demand of external benefits produced by the agriculture in monetary terms, both through indirect methods (contingent valuation method) and through direct methods (hedonic pricing method) (i.e., see Randall 2002).

3.3. Supply-side valuation

From a supply-side valuation perspective, we can distinguish two types of approaches, which are related to different types of costs for externalities/public goods. The first approach looks at the costs of negative externalities (e.g. pesticides contaminating water and harming wildlife, nitrate and phosphate from fertilisers, livestock waste contaminating water, soil erosion, contamination of the atmospheric environment by methane, etc.) while the second approach looks at the (additional) costs for the provision of positive externalities (e.g. increasing the aesthetic value of supply, improving water supply, nutrient fixation, soil formation, biodiversity, enhancing flood control etc.).

The main methods used in the first approach look at the external costs of agriculture, namely at the cost passed to the rest of society through the actions of farmers (Pretty et al., 2000; 2001; Tegtmeier and Duffy, 2004). These methods are mainly based on the evaluation of costs for replacing and/or restoring and/or relocating environmental assets and related goods to comply with legislation or to return these to an undamaged state (e.g. replace soil fertility due to soil contamination or moving existing habitats to alternative sites). Such methods usually also consider administration and monitoring costs, namely the costs incurred by public authorities and agencies for monitoring environmental, food and health parameters.

Nevertheless, in the context of the present study, the most significant approach to be discussed and analysed is the second one, which looks at the supply of positive externalities and especially at measuring the costs of improving the provision of public goods at farm level from current to target/desired levels.

Before discussing how to assess the costs of provision of public goods from this perspective, it is necessary to briefly discuss the relations between farming activities and the provision of public goods.

Farming activities may provide different public goods at many different levels. As discussed in the previous section, in many cases public goods are jointly produced with private goods. Absence of jointness between the provision of private and public goods can be found in those activities that are explicitly devoted to the provision of public goods with no implication on private products production or processes at all. This is the case of activities related to taking care of landscape elements (hedges, rural paths, etc.) and the costs of those activities may be easily assessed since no interaction with other activities (market/non-market) occurs.

Nevertheless, in the majority of cases there is a degree of jointness between the provision of private goods (i.e., food) and public goods (i.e., landscape). Joint production, indeed, deals with the production of public goods (socially valued but non-remunerated) as a by-product/co-product of ordinary agricultural activities.

The literature recognises three sources of jointness (OECD, 2001; 2008):

- Jointness due to technical interdependency (inherent features of the production process governed by biological, chemical, and physical relationships);
- Jointness in non-allocable inputs (i.e., multiple outputs are obtained from one and the same input, e.g., grassland and meadow);
- Jointness in allocable fixed inputs (e.g., land and labour are typically fixed for one farm but can be allocated to different activities).

What makes the issue of jointness particularly challenging is that usually the overall jointness of a farm (or of a farm activity) is a combination of these different sources, and that in many cases multiple public goods are influenced by the same production process. To make an example, when saving fertiliser processes are adopted, this improvement affects the production process (with related costs) but it has also effects on different public goods (e.g., soil quality, water quality and climate stability).

In general, specific farming practices and appropriate farm management can contribute to the provision of agri-environmental public goods in several ways, and generally when such practices bring also private benefits (high level of jointness) to farmers, farmers are more willing to adopt such practices. To simplify, we could argue that especially extensive farming systems are usually associated to practices that deliver positive externalities (for example by enhancing the aesthetic value of landscape, protecting the habitat for flora and fauna etc.). Conversely intensive or conventional farming usually creates negative externalities which may cause environmental damages (soil erosion, water and air pollution, reduced biodiversity and impoverished landscape).

Table 5: Examples of farming practices affecting the provision of public goods

Public goods	Farming practices
Soil protection and quality	Manage soil conservation and runoff Increase soil cover
Water quality	Reduce agrichemical use Establish vegetative buffers Improve nutrient management Grow trees
Water quantity/availability	Promote efficient use of water Keep water in paddy fields in winter
Air quality	Improve livestock manure management Improve pesticides management
Climate change - greenhouse gas emission	Capture and destroy methane from animal waste storage structures Timing of fertiliser applications Reduce burning
Climate change - carbon storage	Manage soil organic matter Reduce tillage Convert cropland to grassland or forest
Biodiversity	Protect breeding areas and wild food sources Improve timing of cultivation Increase crop species/variety diversity Reduced use of toxic chemicals
Agricultural landscape	Coordinate crop species Drying cultivated rice in a traditional way
Resilience to natural disasters	Create diversion, wetlands, storage ponds Manage irrigation systems

Source: Elaborations on OECD (2015).

The main method to carry out an economic valuation of public goods provided by farming using a supply-side perspective is pricing them according to costs of their provision. Such costs could be divided in two types:

- Opportunity costs: additional costs and/or income loss due to implementation of specific government schemes aimed at improving public goods provision (i.e., CAP agri-environmental measures). The value of the positive externality is estimated as cost for the compliance: costs imputed to the adoption of specific practices and income forgone due to yield loss.
- Transaction costs: costs related to farmers decision-making once they are involved in a mechanism for public goods provision (e.g. information gathering, training, advisory, etc.) and their compliance of commitments apart from the opportunity costs (e.g. bureaucracy).

While the calculation of transaction costs may be quite challenging and complex, the calculation of opportunity costs could be a good starting point to assess the cost of public goods provision for farmers. At the same time, to make a sound analysis of opportunity costs, prior knowledge of the joint provision is required, since there is a high heterogeneity of such joint provision, and thus on the costs. This heterogeneity largely depends on the production techniques and practices used, but also by the type of agricultural system (e.g. cropping vs livestock system; irrigated vs dry etc.) and by the main socio-economic factors such as farm size, farm infrastructures, historical factors (e.g., the existence of traditional practices), farmers characteristics (age, gender, education and training, etc.).

In greater details, in order to carry out this type of assessment it is necessary to take into account (Villanueva et al., 2017):

- The features of the farming system assessed, which affect the type and the differences in terms of joint provision and then, indirectly, the cost function.
- The main socio-economic factors, because also within the same agricultural system with similar production techniques used, the willingness to improve the provision of public goods may be different due to the different socioeconomic characteristics of farms and farmers.
- Since we are valuating changes in the provision of public goods, there is a need for defining the change to be evaluated. Therefore, it is necessary to define the initial and target levels of provision representing the range of levels that would be the object of the valuation.

Indeed, opportunity costs of land and labour may vary to a large extent between extensive regions (with risk of land abandonment) and intensive regions (with risk of further intensification). Generally, in intensive regions opportunity costs for land and labour are quite relevant and a combination of these two types of costs may give a good indication of the 'income foregone' due to the maintenance and/or provision of public goods. On the opposite, in extensive regions characterised by a high risk of ceasing traditional agricultural practices, the calculation of 'income foregone' would lead to a consistent underestimation of the actual costs of ensuring a continued management of these areas and of the related provision of public goods. While in the case of intensive areas the compensation of this income foregone can be based on marginal costs (*) only, in the second cases farmers should be also compensated also for fixed costs.

To synthesise, it can be argued that the cost of public goods provision depends on many factors, which should be taken into consideration. In addition, the methods assessing the costs for stimulating public goods provision do not give information about the individual demand regarding the goods and services available. If we consider the CAP agri-environmental measures, for example, where farmers are paid for the extra-costs in providing environmental public goods, the government payment does not reflect, in general, the price that consumers are willing to pay to have that public good. To know the economic value that consumers assign to public good, demand-side valuation methods are needed.

(*) Marginal costs are the costs for producing one additional unit of a good and refer typically to variable costs and to fixed costs.

3.4. Demand-side valuation

Based on the definition of public goods above specified, we shall discuss in the following paragraphs the theory and methodology for assessing public goods' value from a demand side perspective, based on literature evidences.

It must be specified that literature presents several valuation methods, both monetary and non-monetary. Monetary methods' output is an amount of money able to let consumers indifferent when a specific variation in the quantity of public good occurs.

Non-monetary methods, on the contrary, give information about ordinal priorities regarding public goods (i.e. ordered scale of goods or characteristics). Some of the methodologies (i.e. multi-criteria analysis) can combine both numerical variables (e.g. monetary) and qualitative information. Non-monetary methods, however, will be omitted in the following chapters, since the result is far from an accounting perspective and mainly used for supporting governance decision-making ⁽⁵⁾. A classification of the evaluation methods is shown in table 6.

Table 6: Public goods and bads: evaluation methods

	Type of valuation method	Method		Type of assessment
Monetary	Direct market valuation	Price based		Mainly demand
	Indirect market valuation	Production based		Mainly supply
		Cost based	Avoided cost	Demand and supply
			Replacement/relocation cost	Demand and supply
			Mitigation/restoration cost	Demand and supply
	Revealed preferences	Travel cost		Demand and supply Mainly demand
		Hedonic prices		
	Hypothetical market valuation	Stated preferences	Contingent valuation	Demand and supply
			Choice experiment	Demand and supply
			Group valuation	Demand and supply
Others	Benefit transfer		Demand and supply	
Non Monetary	Multicriteria analysis	AHP/ANP		Mainly demand
	Expert based	Dephi methods and others		Demand and supply
	Deliberative assessment	Citizens' juries and others		Demand and supply

Source: Villanueva et al. (2017).

⁽⁵⁾ For a more comprehensive discussion see Villanueva et al. (2017)

3 Public goods - produced by farmers

In contrast with private goods, public goods show the presence of both consumers' utilities obtained from direct consumption and utilities not associated with goods' use. This is the reason why economists introduced the concepts of direct use, indirect use and non-use value. The definition refers to the public goods' potential different consumption (utility produced by non-consuming behaviour is here allowed).

Value coming from direct use refers to the traditional consumer theory, even if it must be noted that decreasing utility is often rejected due to the presence of the phenomenon called "incremental consumption". This is the case when actual consumption will positively influence future consumption not caused by a shift or a modification in consumption styles or consumers' preferences, but simply because the original consumption created a better knowledge and a positive experience able to stimulate future consumption. In other words, environmental goods - as well as cultural goods - develop a process of knowledge accumulation able to influence and increase future individuals' consumption choices.

In figure 1 a classification scheme of different value definition is shown. If we try to apply these values to the clean water we will find that direct use comes from the benefit given to those who actually drink clean water (benefit given by the direct use of the good), indirect use may be associated to those who benefit from utilities given by a lower pollution level. Option value is to be considered, on the contrary, in relation to those who may not use water right now but may decide to drink it in the future.

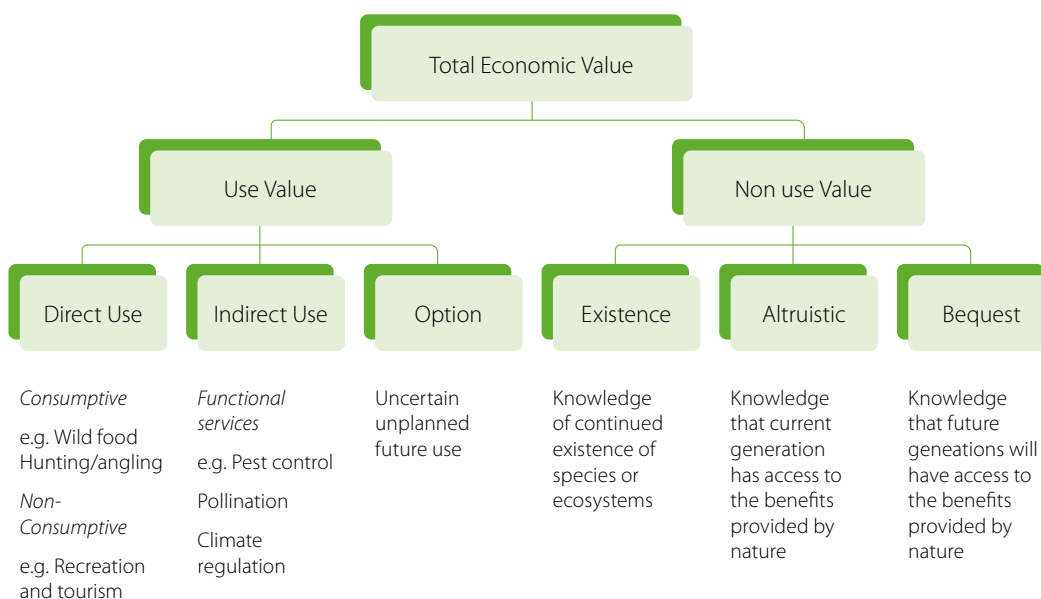
Referring to the option value, it must be cited that literature shows different approaches regarding value classification. Option value in the figure 1 is shown as part of Use Value, whilst other authors (among others Pearce et al, 2003) prefer to include it between Non-Use Values.

Non-use value values are classified in existence value that is shown by consumers who obtain utility simply by the knowledge that the good exists and will exist in the future. Altruistic value refers to the utility a specific person shows by allowing others to have a potential consumption. Bequest value is similar to altruistic value but differs because the potential consumption is reserved to future generations.

The sum of all the values mentioned leads to the concept of total economic value (TEV) defined as the sum of the values of all service flows associated with the public good.

The relative importance between use vs non-use values must be taken into accurate consideration. When dealing with environmental public goods most of the values are referred to non-use aspects that, however, are the most difficult to evaluate and ambiguous to define precisely. A study carried out by Jacobs (2004) in Scotland found that 99% of the overall value of such sites was non-use. This raises the attention of those who make use of the values coming from demand side approaches, since non-use values can differ substantially as a consequence of experiment design or data collection methods.

Figure 1: Total Economic Value and its components



Source: EFTEC (2015).

The Total Economic Value can be assessed on the basis of the Willingness To Pay (WTP) or the Willingness To Accept (WTA) a certain money amount in order to vary consumer welfare. This variation explains why when experimental studies approach Total Economic Value they refer to a welfare (utility) change due to a variation in the public good/service available amount.

This monetary variation is given by the so-called consumer's surplus. This surplus is defined by the difference between the sum of the money a consumer is willing to pay for each unit consumed and the total amount actually paid for the total amount purchased (for public goods the amount paid for consuming the good equals to zero).

A huge variety of research studies were devoted to procedures aiming at the quantification (elicitation) of WTP/WTA. A useful classification distinguishes how consumers' preferences are obtained (see table 6). Methods based on revealed preferences (principally travel costs and hedonic pricing) observe preferences studying the actual decisions people make and refer only to use value, while in stated preferences methods consumers reveal their preferences through questionnaires (principally contingent valuation, choice experiment) that describe the starting public good provision level and its variation.

Literature shows several investigations devoted to the estimation of public goods through WTP/WTA methods, at different scale level (local, regional, national and transnational level). Among others, meta-analysis can be found in Madureira et al. (2006), Villanueva et al. (2017), McVittie et al. (2009), Santos et al. (2016), DEFRA (2007), Willis et al. (2003).

When assessing WTP and WTA in empirical investigations several critical points emerge that still relegate most of the efforts to an academic level or pilot study. Specifically, caveats emerge with respect to the following aspects:

- Scale identification: the correct definition of the basins within which public goods show their effects can be easy in some cases, but very hard in other circumstances. Carbon sequestration, biodiversity and animal welfare are examples of broad public goods that refer to multinational level. Water quality, for instance, implies hydraulic knowledge on a geographical base referred to the specific resource analysed, while recreational services may have an easier target to define.
- Target consumers' group: the scale identification issue leads to the correct identification of the consumers' group/s involved in consumption of the specific public good. Then the identification of a sample statically representative of the consumers' group must be carried out. Several investigations do not give any information regarding the sample representativeness.
- Joint consumption: when a consumer approaches a public good, often a joint consumption emerges. Recreational activities in naturally protected area show consumers' access not only to specific facilities but to landscape, wildlife, etc. as well. From an economic point of view these public goods show complementary consumption relationships characterised by non-separable benefits (OECD 2001). This implies that a separate estimate is impossible.
- Existence of trade-offs in the demand: when describing the variation level in the estimated public goods hardly negative relationships with other public goods are shown. The search for an increase in a particular good may have opposite effects to other public good. This is the case, for instance, of an increase in the access to a site for recreational use that implies a detriment in wildlife preservation, waste production, ecosystems' interferences and future access possibilities (option value).
- WTP/WTA Elicitation: researchers still discuss and work on aspects related to distortion in WTP/WTA elicitation due to:
 - ̄ Hypothetical payment/acceptance: consumers face a virtual market without real payments or rewards. This is the basic reason why often stated preferences (the interviewed respond to specific questions about WTP/WTA) differ from revealed preferences (that are observed studying the actual decisions people make).
 - ̄ Questionnaire complexity: more the interview become complex more the consumer's preferences don't seem to remain stable along the whole interview.
- Risk/uncertainty: several situations imply decision under risk or uncertainty. This often occurs when showing a WTP/WTA without knowing prices of other goods, income level, public good consumed quantities and substitute goods that are available and will be available in future, shift in consumers'

preferences toward substitute goods that are not taken into account. In addition, wealth variation measures (nominal or compensated) are difficult to be considered when several other variables show different possible outcomes.

- Consumer behaviour: risk attitude with respect to potential future levels of variables. Risk aversion is a cardinal property demand function whilst the function is usually estimated in an ordinal framework. The option value is often related to the consumer's risk attitude (positive when risk adverse, zero for risk neutral, negative for risk loving).
- Inter-temporal preferences: economic theory relies on the principle of the consumer preference for present consumption against a consumption postponed in future. This seems to be somehow in contrast with the concept of bequest value and option value when the consumer prefers avoiding actual consumption (show utility in preserving a resource for future generations or simply postponing its consumption). In addition, when estimating option value, a future demand is supposed to exist, but this hypothesis is given at present level of income and other variables that affect actual consumers' demand.
- Identification of the counterfactual outcome (or environmental baseline): consumer face a hypothetical variation in the public good often without knowing the counterfactual dynamic in absence of intervention (or knowing only the information made available by the interviewer who himself make choices based on partial information or faulty scenarios).
- Interactions and substitution effects: already cited and discussed risk and uncertainty, WTP/WTA elicitation are carried out presenting different level of the estimated public good/service. These scenarios are built given all the other variables constant, while often interaction and substitution dynamics occur as well as regarding private goods. This happens typically when dealing with use value and utility change due to consumption decision. For instance, a consumer may tend to compensate for a lower available quantity of a good simply increasing the consumption of another good. Ignoring this effect may lead to an overestimation of WTP/WTA since no consumption alternative is supposed to be available.

Several caveats have already been cited and discussed referring to the hypothesis given for granted when applying quantitative procedures aiming at evaluating public goods. More attention must be devoted to comparing and adding values obtained in different conditions. An example is given by Cooper (2009) who carried out a meta-analysis based on several studies - each focusing on a particular public good - that ends "... A basic valuation of public goods provided by agriculture in Scotland could simply sum the household WTP values for public goods that are present in Scotland. Alternatively, values could be expressed in terms of the value of public goods provided per unit of land. The latter approach which is taken in environmental accounts for agriculture indicate that there are net benefits arising from agriculture, in terms of environmental public goods, with a value estimated to be £266.3 million in 2007".

3.5. Policy instruments

In order to achieve the desired level of public goods, policy action is necessary. However, the types of policy instruments needed to ensure the provision of public goods depend on the nature of externalities produced (the negative externalities configure as public bads, while the positive externalities are public goods) as well as on the level of jointness between such externalities and the related farming activities.

The combination of different level of jointness with the types of externalities determines, *de facto*, the nature of the public intervention needed to ensure an adequate provision of public goods (figure 2).

In case of negative externalities, the type of policy intervention will depend on the level of jointness with farming activities. In case of not jointed production, the environmental harms produced by farmers will be regulated through sanctions and penalties. On the opposite, in case of jointness between the negative externalities and farming activities, command and control policies are needed and, in line with the Polluter Pays Principle, farmers and land managers must comply with legislative requirements or other binding standards and they must absorb these costs themselves.

Similarly, in case of positive externalities we can distinguish two scenarios. In case of absence of jointness, the policy tools that encourage farmers to provide public goods are specific incentives and contracts which could be settled by either public administrations or private actors (e.g., to introduce hedgerow and other ecological areas in agricultural areas). In case of jointness, specific payments need to be ensured to farmers to promote specific farming practices (e.g. cultivation of local varieties and breeding of endangered species to preserve biodiversity).

Figure 2: Public intervention according to the type of externalities and the presence of jointness

		Externalities	
		-	+
Jointness	no	Environmental harm <i>(sanctions, penalties)</i>	Additional environmental value <i>(incentives/contracts)</i>
	yes	Compliance <i>(command and control)</i>	Inherent environmental value <i>(payments)</i>

When looking more specifically at the most relevant policies for the farming sector, it is possible to recognise the different policy instruments that are currently in place in the different combinations described above. While the environmental harms are regulated by environmental policies, the agricultural policies, the payments for ecosystem services in agriculture and the rural development support, they all play a key role in the other cases (figure 3).

Figure 3: Role of agricultural and rural development policies

		Externalities	
		-	+
Jointness	no	Environmental policies	Payments for ecosystem services
		Environmental harm <i>(sanctions, penalties)</i>	Additional environmental value <i>(incentives/contracts)</i>
	yes	Cross compliance	Result-based schemes
		Compliance <i>(command and control)</i>	Agri-environmental payments
		Inherent environmental value <i>(payments)</i>	

3.6. Data needs and implications for the EAA

In this section the data necessary to set up an accounting of public goods produced by the agricultural sector will be discussed.

First, it should be noted that the methodologies for assessing public goods based on demand-side valuation require specific studies aimed at quantifying the willingness to pay/accept. Currently, such information is not available in any of the national accounting or FADN databases. The contingent valuation appears to be the most widespread methodology. Other evaluation methods such as hedonic price or choice experiment appear to be of little use, others even at the experimental level.

In addition, targeted studies for each single environmental good are required, and it must be emphasised that the value obtained is mainly attributable to non-use values. This contrasts with the setting of the economic accounts, which instead show market prices.

The availability of data at the aggregate (national accounting) or farm level (FADN) allows instead to make some additional considerations on the evaluation methods based on a supply perspective.

3 Public goods - produced by farmers

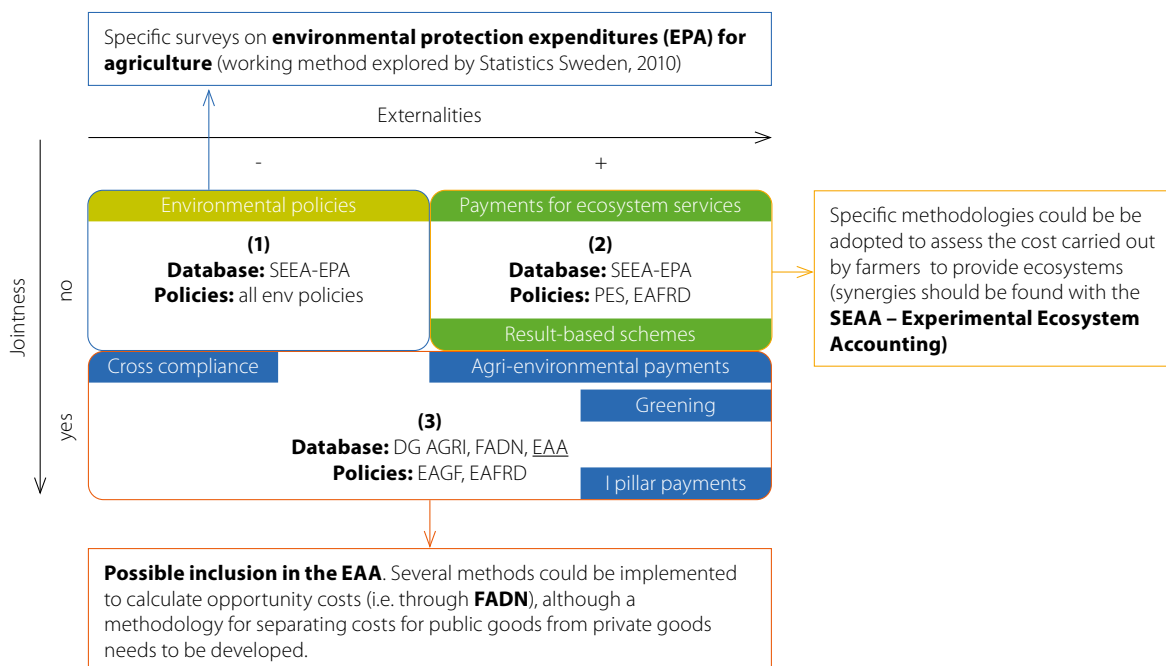
This involves analysing the costs incurred by farmers (at aggregate level or farm level depending on data availability) to produce environmental goods or avoided costs for the restoration of damaged environmental assets.

To synthesise, we can mainly consider 3 different cases:

1. **Presence of negative externalities not jointed to farming practices.** As presented in section 3.3, in this case the costs to be evaluated refer to those for replacing and/or restoring and/or relocating environmental assets and related goods to comply with legislation or to return these to an undamaged state. For these typologies of costs, the most suitable database could be the Environmental protection expenditure accounts (EPEA), which describe production, consumption, investment, transfers and employment in environmental protection products or activities. The main aggregate is the national expenditure on environmental protection. EPEA is one of the European environmental accounts, which are compiled in line with the national accounts. As regards the possibility of including environmental protection expenditure in agriculture, an interesting attempt was made by Statistics Sweden (2010), which proposed a working method for the collection of such statistics in agriculture.
2. **Presence of positive externalities not jointed with farming practices.** In this case, specific methodologies could be adopted to assess the costs carried out by farmers to provide ecosystem services in the framework of private or public contracts with business actors or public administrations (e.g. PES - payments for ecosystem services or EAFRD result based schemes). In terms of biophysical data availability, some synergies should be found with the SEEA – Experimental Ecosystem Accounting, which can be considered an important first step in the development of a statistical framework for ecosystem accounting.
3. **Presence of negative or positive externalities jointed with farming practices.** In this case, when information is available, several methods could be implemented to calculate opportunity costs. Since most of the policy tools implemented in the CAP fall into this category, data and methods used to calculate additional costs/income foregone through FADN data could be very helpful. At the same time, a methodology for separating costs pertinent to the public good and the private one could be developed both at macro (EAA) and micro level (FADN).

In figure 4, different available sources of data are reported with respect to both the provision of public goods in agriculture and the main policy tools actually implemented.

Figure 4: Databases and sources



As showed in the figure , the third case is also the most suitable also for a possible inclusion of valuation of public goods in the EAA. At this regard, probably the most reasonable action to be taken will be defining the relations between specific practices and public goods at farm level (see table 7).

All the data referring to the policy tools relevant for the third case (presence of negative or positive externalities jointed with farming practices) are available at DG AGRI level. Such data regard both direct payments and rural development programmes (RDP). Direct payments contribute, through greening, and in combination with cross-compliance, to providing basic public goods. The system of direct payments (managed directly by the EU) is complemented by RDP (managed at national and/or regional level), which contain a broad range of measures relevant for public goods (e.g. measures for the environment and climate change). In 2014-20 programming period there are 118 different RDP, with 20 single national programmes and 8 Member States with two or more (regional) programmes. All the data regarding the expenditures and the measures implemented in each RDP are communicated yearly to DG AGRI.

Table 7: Link between specific farming practices, public goods provision and related policies

Public good	Farming practices	Policies
Soil protection and quality	Manage soil conservation and runoff	Cross compliance, RDP measure for the increase of organic matter and for minimum tillage
	Increase soil cover	Greening, RDP measures
Water quality	Reduce agrichemical use	RDP measures, private contracts
	Establish vegetative buffers	Cross compliance, greening, RDP measures
	Improve nutrient management	Cross compliance, RDP measures
	Grow trees	Greening, RDP measures
Water quantity/availability	Promote efficient use of water	RDP measures
	Keep water in paddy fields in winter	—
Air quality	Improve livestock manure management	Cross compliance
	Improve pesticides management	RDP measures, private contracts
Climate change - greenhouse gas emission	Capture and destroy methane from animal waste storage structures	RDP measures, national energy policies
	Timing of fertiliser applications	Fertilisation schedule, precision farming
	Reduce burning	Green manure and burying crop residues
Climate change - carbon storage	Manage soil organic matter	RDP measures
	Reduce tillage	RDP measures
	Convert cropland to grassland or forest	Greening, RDP measures
Biodiversity	Protect breeding areas and wild food sources	RDP measures, local policies
	Improve timing of cultivation	—
	Increase crop species/variety diversity	RDP measures
	Reduced use of toxic chemicals	Cross compliance
Agricultural landscape	Coordinate crop species	Greening, RDP measures
	Non-farmed features	Cross compliance, Greening, RDP measures
	Drying cultivated rice in a traditional way	—
Resilience to natural disasters	Create diversion, wetlands, storage ponds	RDP measures
	Fire prevention	Local policies
	Manage irrigation systems	Local policies, private contracts, RDP measures

4

Public goods produced by farmers as part of the EAA

In the project experts' opinion, the present study, which was looking at the issues from the EAA (basic concepts and structure) point of view, cannot measure the value of public goods produced by farmers as value for society, but investigated the information and the level of detail currently existing in EAA related to public goods. This information could, at the end of the evaluation chain, represent a part of the value of public goods produced by farmers.

Having in mind the objective of the project and considering the outcome of the analysis made with in the chapter 3, the public goods listed in the table 8 are to be considered for the purpose of the present study.

Following the identification of public goods to which the production of the agricultural sector is contributing, an identification of the specific activities of the related farming practices was made. This is supporting the assessment related to already existing information linked to production of public goods as well as their registration in EAA.

Table 8: Specific farming activities and public goods provision

Public good	Farming practices	Specific activities
Soil protection and quality	Manage soil conservation and runoff	Managing and channeling water - surface, minimum tillage
	Increase soil cover	Cover crops, green cover, buffer strips
Water quality	Reduce agrichemical use	Organic and integrated farming
	Establish vegetative buffers	Buffers strips
	Improve nutrient management	Fertilisation schedule, precision farming
	Grow trees	Agro-forestry, re-forestation of river basin, buffer strips
Water quantity/availability	Promote efficient use of water	Adoption of drip-irrigation and other irrigation techniques reducing the use of water
	Keep water in paddy fields in winter	—
Air quality	Improve livestock manure management	Scheduled manure spread in the fields, feeding mix
	Improve pesticides management	Organic and integrated farming
Climate change - greenhouse gas emission	Capture and destroy methane from animal waste storage structures	Bio-based energy production
	Timing of fertiliser applications	Fertilisation schedule, precision farming
	Reduce burning	Green manure and burying crop residues
Climate change - carbon storage	Manage soil organic matter	Rotation, green manure
	Reduce tillage	Minimum/no tillage
	Convert cropland to grassland or forest	—

Public good	Farming practices	Specific activities
Biodiversity	Protect breeding areas and wild food sources	Non-productive crops
	Improve timing of cultivation	—
	Increase crop species/varietal diversity	Cultivation of endangered species and varieties
	Reduced use of toxic chemicals	Calibration and maintenance of equipment and machineries, precision farming
Agricultural landscape	Coordinate crop species	Rotation, diversification, strip tillage
	Non-farmed features	Introduction and/or maintenance of hedges, stonewalls, wetlands, etc.
	Drying cultivated rice in a traditional way	—
Resilience to natural disasters	Create diversion, wetlands, storage ponds	Timing/restrictions on mowing/cutting/ploughing
	Fire prevention	Introduction and/or maintenance of firebreaks
	Manage irrigation systems	Management of water reservoir, management of flood channels

Looking at the public goods, the farming practices and the specific activities linked to it the following questions arise:

Which information related to the production of public goods exists in EAA?

Where is this information accounted in EAA?

The Economic Accounts for Agriculture are compiled in accordance with the basic concepts and rules of the European System of National and Regional Accounts in the Community. Regulation EC No 138/2004 sets up the EAA methodology (common standards, definition, classifications and accounting rules) which limits the EAA compilation and provides a common /comparable data base.

The most straight forward available information linked to production of public goods is the information on subsidies and other support to farm sector.

The Regulation (EC) No 138/2004 of the European Parliament and of the Council on which the EAA compilation is based defines subsidies as "unrequited payments which general government or the institutions of the European Union make to resident producers, with the objective of influencing their levels of production, their prices or the remuneration of the factors of production. Other non-market producers can receive other subsidies on production only if those payments depend on general regulations applicable to market and non-market producers as well. By convention, subsidies on products are not recorded on other non-market output (cf. ESA 2010, 4.30)"

The subsidies are classified as following:

- subsidies on products:
 - ̄ import subsidies;
 - ̄ other subsidies on products;
- other subsidies on production.

Subsidies on products are subsidies payable per unit of a good or service produced or imported. The subsidy may be a specific amount of money per unit of a good or service, or it may be calculated ad valorem as a specified percentage of the price per unit. A subsidy may also be calculated as the difference between a specified target price and the market price actually paid by a buyer. A subsidy on a product usually becomes payable when the good is produced, sold or imported. By convention, subsidies on products can only pertain to market output or to output for own final use (cf. ESA 2010, 4.33).

Other subsidies on production consist of subsidies other than subsidies on products, from which resident producer units can benefit as a consequence of engaging in production. For their other non-market output, other non-market producers can receive other subsidies on production only if these payments from general government depend on general regulations applicable to both market and non-market producers (cf. ESA 2010, 4.36). The ESA 2010 refers to four other subsidies on production (cf. ESA 2010, 4.37): subsidies on payroll or workforce, subsidies to reduce pollution, grants for interest relief, and over-compensation of VAT. These payments relate mainly to the assumption of production costs or support for changes in the method of production.

Within the Table 9 a description of the subsidies by type, as exists in the EAA regulation is made. In parallel, based on project experts' experience, an example on type of subsidies included in EAA is presented, **underlining** the type of subsidies linked to the production of the public goods.

Table 9: Examples of subsidies/ grants contained in EAA (6)

EAA Regulation	Example of total subsidies registered in EAA - out of which linked to production of public goods
PRODUCTION ACCOUNT	
<p>Subsidies on products Subsidies on products are subsidies payable per unit of a good or service produced or imported.</p>	<ul style="list-style-type: none"> • payment for animal welfare – cattle • coupled support for different products - cows, ewes, rice, sugar beet, protein crops, oil seeds, vegetables, fruits • other national subsidy - Beekeepers Program paid by number of beehives • prevention and control of transmissible diseases in animals and zoonoses
INCOME ACCOUNT	
<p>Other subsidies on production (23) The ESA 2010 refers to four other subsidies on production (cf. ESA 2010, 4.37):</p> <ul style="list-style-type: none"> • subsidies on payroll or workforce; • subsidies to reduce pollution; • grants for interest relief, and over-compensation of VAT. <p>These payments relate mainly to the assumption of production costs or support for changes in the method of production.</p>	<ul style="list-style-type: none"> • payment for agri-environment-climate commitments • payment to convert to organic farming practices and methods • payment to maintain organic farming practices and methods • support for establishment and maintenance of agro-forestry systems • compensation payment for other areas facing significant natural constraints • afforestation of agricultural land • compensation payment for Natura 2000 agricultural areas • setting-up of producer groups and organisations • business start-up aid for young farmers • payment for young farmers • support for conservation and sustainable use and development of genetic resources in agriculture • Small Farmers Scheme • greening • single area payment scheme
CAPITAL ACCOUNT	
<p>Investment grants Investment grants are capital transfers, in cash or kind, effected by general government or the rest of the world to other resident or non-resident institutional units with the aim of financing, in part or in full, the cost of acquiring fixed capital goods (cf. ESA 2010, 4.152). Investment grants from the rest of the world comprise those granted directly by the institutions of the European Union via the European Agricultural Guidance and Guarantee Fund (EAGGF) Guidance Section.</p>	<ul style="list-style-type: none"> • support for investments in agricultural holdings (animal keeping plots, mushroom house, greenhouse, storage, improving of animal farms, manure storage facilities) • support for investments in processing/marketing and/or development of agricultural products (partly) • business start-up aid for the development of small farms

EAA Regulation	Example of total subsidies registered in EAA - out of which linked to production of public goods
SUPPORT NOT COVERED IN THE EAA	
<p>The EAA does not treat the following as subsidies:</p> <ul style="list-style-type: none"> • current transfers which, although they are subsidies within the meaning of the EAA, are not paid to agricultural production units. — current transfers to agricultural producer units by a market-regulating agency; • exceptional transfers by professional bodies to agricultural production units; • current transfers by general government to households in their capacity as consumers; • capital transfers: these are different from current transfers in that they involve the acquisition or disposal of an asset or assets by at least one of the parties to the transaction; • quasi-corporations intended to cover losses accumulated during several financial years or exceptional losses due to factors beyond the enterprise's control. • compensation paid by general government or the rest of the world (i.e. from abroad and/or by the institutions of the European Union) to the owners of fixed capital goods engaged in the production of agricultural products, as a result of exceptional and catastrophic losses such as the destruction of or damage to these goods caused by acts of war, other political events or natural disasters • cancellations of debts which the producers of agricultural products have contracted with general government (e.g. advances from general government to a producer enterprise which has accumulated operating losses over several financial years). • the abatement or lowering of taxes on production, income or wealth is not explicitly stated in the ESA 2010 or, consequently, in the EAA, since only taxes which are actually levied are accounted for; • shares and participating interests held by general government in the capital of agricultural corporations and quasi-corporations. 	<ul style="list-style-type: none"> • basic services and village renewal in rural areas • compensation payment for Natura 2000 forest areas • payment for forest -environmental and climate commitments • preparation and implementation of cooperation activities of the local action • support for (crop, animal and plant) insurance premium • support for afforestation/creation of woodland • support for diversification of farming activities into activities concerning health care, social integration, community-supported agriculture and education about the environment and food • support for horizontal and vertical co-operation among supply chain actors for the establishment and development of short supply chains and local markets, and for promotion activities in a local context relating to the development of short supply chains and local markets • support for investments improving the resilience and environmental value of forest ecosystems • support for investments in creation and development of non-agricultural activities • support for investments in forestry technologies and in processing, mobilising and marketing of forest products • support for investments in preventive actions aimed at reducing the consequences of probable natural disasters, adverse climatic events and catastrophic events • support for investments in the creation, improvement or expansion of all types of small scale infrastructure, including investments in renewable energy and energy saving • support for joint action undertaken with a view to mitigating or adapting to climate change, and for joint approaches to environmental projects and ongoing environmental practices • support for non-productive investments linked to the achievement of agri-environment-climate objectives • support for restoration of damages to forests from forest fires and natural disasters and catastrophic events • support for short-term farm and forest management exchange as well as farm and forest visits • support for the conservation and promotion of forest genetic resources; • support for the establishment and operation of operational groups of the EIP for agricultural productivity and sustainability • support for training of advisors • support for vocational training and skills acquisition actions • support to help benefiting from the use of advisory services

(*) Examples linked to production of public goods are highlighted in red.

Most of the subsidies highlighted in the table ensure an economic support to farmers to encourage them to adopt specific types of farming (e.g. organic, extensive agriculture), or to adopt specific farming practices (e.g. crop diversification, afforestation, etc.) which are aimed at increasing the provision of one or more public goods.

As it can be observed in the table 9 above not all the subsidies are covered by EAA. Some measures founded by the European Union on the field of agriculture, forestry, rural development or environment, which are subsidies within the meaning of ESA, are not accountable on EAA because they are not paid to agricultural production units or are not related to agricultural activity. Parts of these are accounted on different other satellite accounts such as European Environmental Economic Accounts or European Forest Accounts (EFA, formerly IEEAF).

4 Public goods produced by farmers as part of the EAA

Considering the defined public goods on one side and the existing information on the other side, the following options can be suggested for the partial valuation of public goods based on EAA information:

1. Valuation of public goods produced by farmers based on the information on subsidies;
2. Valuation of the specific farm-sector costs included in the EAA data base which can be linked to the production of public goods.

In many cases the evaluation of PG based on subsidies is not easy to manage since subsidies cover extra costs for providing environmentally valuable agricultural outputs (different from those that would be preferred by farmers without restrictions or incentives) or following environmentally sound procedures. However, only in few cases a direct link between subsidies and specific public goods can be examined. This is the case of particular CAP measures, falling into the so called agri-environmental schemes. Examples of such subsidies could be found in:

- practices specifically devoted to soil protection from erosion (cover crops);
- cultivations dedicated to wild-fauna habitat enhancement and supplemental wildlife food planting;
- breeding and conservation of animal/vegetable endangered species subject to genetic erosion (especially if joint production of meat, milk, or services is missing);
- payments and practices devoted to achieving environmental and climate achievements (e.g CO₂ storage);
- afforestation of agricultural land;
- introduction/maintenance of hedges, stone walls, wetlands, other traditional landscape characteristics;
- introduction of buffer strips;
- introduction and maintenance of firebreaks;
- creation/management of water reservoir, flood channels and environmental corridors;
- others.

In the above-mentioned cases, the absence of joint production between ordinary agricultural outputs and public goods leads to consider the subsidies entirely devoted to public good production, and consequently as a reasonable proxy of public goods' provision costs, which fits the value assessment procedure based on the cost approach.

For all the other subsidies which do not have such characteristics a sort of "weighting coefficient" should be defined, in order to discriminate between the costs and/or effects pertinent to public goods' provision and the costs and/or effects devoted to private goods' production, since both are jointly produced and the subsidy aims at increasing the supplied quantity of the public goods by increasing the private goods production.

In the latter case, the valuation is very challenging, due to the number and the complexity of relations between farming practices and public goods provision. A first classification of such relations has been developed by Cooper et al. (2009) and represented in Figure 5. As showed in the figure, in addition to the problem of jointness between public and private goods provision, the main challenge is related to that fact that individual farming practices usually provide a bundle of public goods. When looking at specific public goods it can be observed that farmland biodiversity, water quality, soil functionality and agricultural landscapes are maintained or enhanced by the largest number of practices - by 53, 43, 36 and 35 farming practices, respectively. Air quality and water availability are improved by only seven and nine practices, respectively, whilst reductions in GHG emissions, improved carbon storage, and improvements in the resilience to flooding and resilience to fire are supported by 22, 18, 17 and 12 practices, respectively."

Figure 5: The range of public goods provided by individual farming practices

	Agricultural landscapes	Farmland biodiversity	Water quality	Water availability	Soil functionality	Climate stability - carbon storage	Climate stability - GHG emissions	Air quality	Resilience to flooding	Resilience to fire
Retention of field boundaries	X	X	X	X	X				X	
Growing crop varieties with lower nutrient/water requirements	X	X	X	X	X				X	
The use of green manure/cover crops		X	X		X	X	X		X	
High proportion of fallow in rotation		X	X	X	X	X		X		X
High proportion of farm as permanent (>10 years) semi-natural vegetation	X	X	X		X	X			X	X
Animals grazed outside	X	X	X		X		X	X		X
The use of flood or water meadows	X	X	X		X	X	X		X	
Transhumance practiced	X	X		X	X	X			X	X
Shepherding of grazing on semi-natural habitats	X	X	X		X	X			X	X
Minimise herbicides applied to crops	X	X	X	X	X			X		
Retention of high proportion of grass on farm	X	X	X		X	X			X	
Hand weeding of crops	X	X	X		X		X	X		
Terrace cultivation	X	X	X		X	X			X	
Maintaining long continuity of extensive management	X	X	X		X				X	X
Active management of wood pasture	X	X			X	X			X	X
Land managed as small fields/plots	X	X	X		X				X	
Minimise pesticides applied to crops		X	X	X	X			X		
Mix arable and livestock within rotation	X	X	X		X					X
Minimal cultivation for cereals (no-till)			X	X	X	X	X			
Active management of wooded meadows	X	X	X			X				X
Ground layer controlled by grazing	X	X	X		X	X				
Minimal use of abstracted water	X	X	X	X						
Watercourses uncanalised	X	X	X						X	
Soil drainage optimised (non-organic soils)			X		X		X		X	
Retain open drainage with significant emergent/riparian vegetation	X	X	X						X	
Long harvesting period	X	X	X		X					
Legumes used as part of crop rotation		X	X		X		X			
Retention of drove roads and tracks	X		X						X	X
Biological control of invertebrate pests		X	X		X			X		
Zero slurry production			X		X		X	X		
Retention of patches of scrub within semi-natural grassland	X	X			X	X				
Use of draught animals	X	X			X		X			

	Agricultural landscapes	Farmland biodiversity	Water quality	Water availability	Soil functionality	Climate stability - carbon storage	Climate stability - GHG emissions	Air quality	Resilience to flooding	Resilience to fire
Retention of dew ponds, small dams, spring fed water troughs	X	X							X	X
Hand mowing of fodder crops	X	X			X		X			
Nutrient management planning		X	X				X			
Application of low levels of N fertilizers		X	X				X			
Retention of single/small groups of trees	X	X				X				
Efficient irrigation techniques			X	X	X					
Use of local breeds	X	X		X						
High groundwater level retained on peat soils		X	X				X			
Feed - high proportion of maize silage			X		X		X			
Feed - high proportion of concentrates			X		X		X			
Use livestock appropriate for semi-natural grazing	X	X								X
Minimise point source pollution		X	X			X				
Retention of old/standard trees	X	X				X				
Retention of traditional farm buildings	X	X								
No ploughing up and down slopes			X		X					
Application of low levels of P fertilisers		X	X							
Small machinery used		X			X					
Retain stone heaps, rock outcrops	X	X								
High groundwater level retained on non-organic soils		X	X							
High digestibility and high nutrient content feed given to livestock			X				X			
Genetic selection for high productivity		X					X			
Pollarding etc for fodder	X	X								
Single mowing for hay or silage		X			X					
High milking frequency		X					X			
Growing locally adapted crop varieties	X	X								
Grain left in field after harvest		X	X							
Biogas production from animal waste			X				X			
Mixed grazing	X	X								
Carcasses allowed to decay in Situ		X	X							
Availability of nectar sources for bees		X								
Use of multi-purpose livestock							X			
Use of high fertility livestock							X			
Lifting root crops by hand					X					
Growth of game crops		X								

Source: Cooper et al. (2009).

Another option which can be considered for the valuation of public goods from agriculture could be to identify the **specific costs occurred in a farm** that can be linked to **the production of public goods** directly into the EAA.

Having in mind the specific activities and also following the MS answer regarding the existence of information related to the production of public goods in EAA, we are able to say that information exists under several EAA items, such as: Other inseparable secondary activities (goods and services); Seeds and planting stock; Energy, lubricants; Fertilizers and soil improvers; Agriculture services; Other goods and services; Fixed capital consumption; Equipment; Others; Compensation of employees; Other subsidies on production; GFCF in major land improvements etc.. However, the situation may vary from country to country and a clear assessment has to be made at each national level.

In order to illustrate the type of information that can be found in the EAA, table 10 presents a non-exhaustive list of examples of activities/ related costs associated with the production of public goods that can be linked to specific EAA items.

Table 10: Example of information related to production of public goods

EAA item/definition	Examples of activities and related costs
<p>17000 Non-agricultural secondary activity (inseparable) Only that part of a specific non-agricultural secondary activity which is inseparable must be included. Therefore, a given non-agricultural activity will be included in the agricultural industry if it is impossible to separate it from the main agricultural activity of a local KAU, but will be excluded if it can be separated from the main agricultural activity, in which case the secondary activity gives rise to a non-agricultural local KAU. The selection criterion for inseparable non-agricultural secondary activities is not so much the nature of the product as the type of activity (1). For example, agro-tourism services provided by a farm must only be included if they cannot be separated from its agricultural activities. This would probably not be the case when these activities become important. Thus, non-agricultural products accounted for in the production of the agricultural industry may vary geographically and over time.</p>	<ul style="list-style-type: none"> landscaping services — grass-mowing, hedge-trimming, snow-clearing, laying out, planting and maintenance of green areas
<p>19090 Agricultural services These agricultural services (which constitute the hire of machines and equipment with the corresponding labour) are an integral part of agriculture (cf. 1.82 to 1.91) and are recorded as intermediate consumption and entered under 'output' as well.</p>	<ul style="list-style-type: none"> costs with additional tasks caused by the cover crops (e. g. more mowing); costs with drip irrigation services (instalment/maintenance); costs with extra activities related to cover crops;
<p>19900 Other goods and services These other goods and services includes among other fees for agricultural consultants, surveyors, accountants, tax consultants, lawyers, etc.;</p>	<ul style="list-style-type: none"> fees for agricultural consultants providing advise related to organic production; cost related to organic certifications and additional records (administrative issues)
<p>19900 - Seeds and planting stock This heading covers the total consumption of bought-in domestic and imported seed and planting stock for current production and maintaining stocks in vineyards, orchards, and Christmas tree plantations. It includes in particular direct purchases of seed and planting stock from other farmers. However, seed produced and consumed within the same unit in the same reference period is not recorded under this heading (cf. 2.052).</p>	<ul style="list-style-type: none"> the additional cost of specific (organic) seeds; or the additional quantity of cover crops seeds.
<p>19020 – Energy, lubricants This heading covers electricity, gas and all other solid and liquid fuels and propellants. It should be noted that only the consumption of energy on agricultural holdings is to be shown, and not consumption in farmers' households.</p>	<ul style="list-style-type: none"> costs related to the specific activities increase due to the additional activities caused by the cover crops (more mowing)

EAA item/definition	Examples of activities and related costs
<p>19030 – Fertilizers and soil improvers Soil improvers include, for example, lime, peat, sludge, sand and synthetic foams.</p>	<ul style="list-style-type: none"> • costs related to the use of organic manure; • cost with organic approved fertilizers and soil improvers.
<p>19040 – Plant protection products and pesticides These include herbicides, fungicides, pesticides and other similar inorganic and organic substances (e.g. poisoned bait).</p>	<ul style="list-style-type: none"> • cost with organic approved plant protection products.
<p>19070 – Maintenance of materials This heading includes:</p> <ul style="list-style-type: none"> ī purchases of goods and services for maintenance (i.e. regular replacement of individual damaged or broken parts) and repairs required to keep capital goods in usable condition (cf. 2.127 to 2.129); ī purchases of crop protection equipment (excluding reparations for plant protection and pest control, cf. 2.101), such as detonators, anti-hail protection, anti-frost smoke, etc. 	<ul style="list-style-type: none"> • costs related to the additional activities caused by the cover crops (more mowing) through machinery usage • costs related to calibration and maintenance of equipment and machineries, precision farming.
<p>21100- Fixed capital consumption; Equipment; The foreseeable wear and tear and obsolescence of fixed capital goods over the accounting period represent a charge which is implicit so long as the item is not replaced by a new acquisition. This wear and tear and obsolescence are measured by fixed capital consumption. Its inclusion under 'uses' in the production account allows expenditure on fixed capital formation to be distributed over the entire period of use. If the economic life of the means of production is more than one year, the consumption of fixed capital represents the amount of fixed capital used up in the production process during the accounting period as a result of normal wear and tear and foreseeable obsolescence. If, on the other hand, the means of production used have an economic life of less than one year, the wear and tear is recorded as intermediate consumption.</p>	<ul style="list-style-type: none"> • Fixed capital consumption related to the machines and other equipment specific for bio farming (cultivators, equipment for mechanical weeds control, pest control etc.).
<p>23000 – Compensation of employees Gross wages and salaries and actual social contributions (for account of employers) are recorded during the period in which the work was performed, although premiums and other exceptional payments are recorded at the time they become due (cf. ESA 2010, 4.12).</p>	<ul style="list-style-type: none"> • Compensation for the work directly linked to special activities related to organic farming , (manual work)
<p>33921 – GFCF in major land improvements Major improvements in non-produced tangible assets correspond mainly to land improvement (better quality of land and higher yield through irrigation, drainage and flood prevention measures, etc.) and should be treated like any other GFCF. Since land acquisitions and withdrawals are not recorded as GFCF (being non-produced assets), investments in land improvement are listed separately under a special GFCF heading.</p>	<ul style="list-style-type: none"> • Measures related to better quality of land and higher yield through irrigation, drainage and flood prevention

An approach of this kind should take into consideration the following aspects:

- There is not a direct link between the activity and the specific public good. One activity can contribute to several public goods while several activities will contribute to the production of a specific public good.
- The cost of one activity cannot be linked exclusively to the cost of the provision of a public good as normally similar activity is carried out in the regular /ordinary production so only the extra/ excessive cost can be attributed to the provision of public goods. For example: from the total costs with the seeds for the production of a certain crop only the additional cost of the organic seed should be attributable for the provision of improved 'water quality' public good through the farming practice of 'reduce agrichemical use'. Similarly, only the cost of the increased cost of labour force would contribute to the provision of public good if the regular plant protection is replaced with the handpicking of potato bugs however the cost of plant protection products is eliminated at the same time. Many similar examples can be drawn based on the agricultural processes and practices.
- In theory the division of the specific cost might be feasible but in practice splitting an existing cost between the regular production activity and the activity carried out in order to provide public goods is not possible.
- Even if we have accurate and detailed information of the costs related to activities taken in the process of providing a specific public good it is not the exact value of the provided public good. The interference or synergy of the activities can influence the value of the public good created.

5

Conclusions/ Recommendations

The scope of the study was extremely challenging as many unknown variables were involved. A common definition of public goods produced by farmers does not exist and current EAA methodology makes no explicit reference to public goods.

Even though the ECA report underlines that the potential of EAA has not yet been fully used and they are “not sufficiently informative about important factors that are relevant for farmers’ incomes, as well as for the economic value of agriculture as a whole” the limitation of the EAA as satellite account focusing on the agricultural sector production process and the primary income generate by it should be considered.

The present report emphasised the complexity of the relations between agriculture and public goods, by showing that farming sector may also provide “public bads” (or negative externalities), which are non-rival and non-excludable goods that may cause harm to people and to the environment. An exhaustive valuation of public goods associated to farming should take into consideration the role of farming as producers of both positive and negative externalities, by considering the overall balance of both positive and negative effects at different spatial and temporal scales.

The report also provided an identification and classification of public goods associated to farming based on the most recent EU studies on the topic. The most relevant agri-environmental public goods were identified (agricultural landscapes, farmland biodiversity, water quality, water availability, soil functionality, climate stability air quality, resilience to flooding and fire), while some ‘functions’ and ‘services’ more related to the socio-political notion of public goods such as food security and rural vitality were not included due to their complex and multidimensional nature, which make them very difficult to be identified and measured.

As regards the economic valuation of public goods, two main approaches were identified: a demand-side and a supply-side approach. The first approach looks at the costs of (positive and negative) externalities from a producers’ perspectives, while demand-side methods look at the economic value that consumers assign to public goods provided by farming.

The EAA, due to its nature and structure, contains some relevant information related to provision of public goods at an aggregate level, namely subsidies and various costs related to specific farming practices. The data on subsidies is currently available under “Subsidies on product” and “Other subsidies on production” but it is presented at aggregate level and does not provide a breakdown by different categories of subsidies.

However, the data on subsidies by type is available at national level. Furthermore, all the Member States shall send an annual report to DG AGRI about the support activities in a given year containing detailed information on the subsidies not only funded by the European Union but by the national budget as well. Based on this, the eligible EAA subsidies related to public goods could be identified but cannot be directly linked to the production of a certain public good (e.g. biodiversity, air quality etc.).

The existing data on costs related to specific farming practices are included in the EAA under different items (agricultural services; other inseparable secondary activities; seeds and planting stock etc.) but on an aggregated level without a breakdown by different categories of costs. The possibility to separately obtain the costs related to specific farming practices needs to be investigated further and will be

directly dependent on the data collection system available in each country. Even if such a distinction were possible, as in the case of subsidies, it still would not be possible to link the costs directly to the production of a specific public good (e.g. biodiversity; air quality etc.) but would provide a global sum on costs related to specific farming practices contributing to the provision of public goods by agricultural sector as defined by EAA.

Nevertheless, one of the main methodological challenges related to the valuation of costs (either directly or indirectly through information on subsidies) is related to the jointness between the provision of private goods (i.e., food) and public goods (i.e., landscape). Indeed, specific farming practices can contribute to the provision of multiple agri-environmental public goods, and generally, such practices bring also private benefits. In case of high level of jointness, it is not possible to separate the costs for public goods from those for private goods and this may prevent a sound valuation of the costs incurred at farm sector level to produce public goods. The possibility to identify and separate the costs would depend on the existing information at the national level.

Following the outcome of the present study it can be concluded that **EAA in its present structure and limitations as defined by EC Regulation 138/2004 applying the ESA rules cannot be considered a suitable tool to measure the value of the public goods produced by farmers.**

Based on the investigation made on the seven selected countries, it could be concluded that the concept and understanding of public goods would first have to be established before undertaking a broader investigation.

If the information on public goods identified by this study is still considered relevant for main data users, then the following issues could be recommended for further consideration:

- broader consultation of the Member States (and other stakeholders) as regards the views on the defined public goods, farm practices and the related specific activities proposed within the present study;
- investigation of the available information at DG AGRI-level (e.g. payments by type and specific activities related to it);
- consequently, with the support of the Member States, the development of innovative methodologies to separate costs pertinent to public and private goods in case of jointness;
- in a final stage develop a separate indicator which would incorporate the information on costs related to production of public goods.

However, when considering the above mentioned issues, it would have to be taken into account that the final outcome would not provide the economic value of the public goods produced by agricultural sector as a final product (taking into consideration the value to society) but only some information on the costs incurred for the provision of public goods. Information on specific payments would also be at an aggregated level and not at the level of a specific type of public good (e.g. biodiversity, air quality etc.).

This exercise could represent a substantial work for both, Commission and Member States side; therefore the potential benefits would have to be carefully assessed.

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Modernisation of EAA - Measurement of the economic value of public goods produced by the agricultural sector

Micro and macro economic statistics are built on different frameworks. They differ in their goals, economic concepts and the way data are produced. The System of National Accounts assures comprehensive, coherent and internationally comparable figures for the household sector at the macroeconomic level. Only micro economic statistics, however, can provide information on the distribution of economic resources among individual or groups of households. The OECD, Eurostat and several countries joined efforts to progress on a methodology that bridges the differences, producing estimates on household income and consumption that are in line with national accounts aggregates, but build onto micro data. In this final report of the Joint OECD-Eurostat Expert Group on Disparities in a National Accounts framework (EG DNA), we describe the methodology and present some experimental distributional national accounts for the household sector.

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