AgriFood economics centre

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Impacts of Direct Payments

Lessons for CAP post-2020 from a quantitative analysis

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FOREWORD

Although the latest CAP reform 2014-2020 has recently been adopted, the discussions among politicians, researchers, farmers and other stakeholders on the essence of the next CAP reform are fully underway. There are pervasive arguments that Pillar I direct payments are not an optimal instrument to address the future challenges faced by agriculture, and that the environmental sustainability of agriculture must improve. There seems to be a rather common view that continued reform is needed, although views differ regarding what to change and how. In this situation quantitative evidence is paramount.

In this report, we hope to contribute to the reform process by analysing the impacts of direct payments on agricultural production, the environment, farm incomes and competitiveness using model simulations. In addition, we analyse whether CAP objectives can be more efficiently fulfilled using two alternative instruments; one based on the Provider Gets Principle, the other based on the Polluter Pays Principle.

We do not provide a proposal for a new CAP. Instead, the idea is to illustrate how direct payments are currently shaping and influencing European agriculture and the environment, and how the policy could be improved if common principles guiding economic policy are more stringently applied in the CAP post-2020.

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CONTENT

Executive summary

In this report we aim to analyse the economic and environmental impacts of Pillar I direct payments, and to demonstrate alternative instruments that are better suited to achieve CAP objectives. The instruments—a targeted payment to land at risk of abandonment and a tax on mineral fertilisers—were selected on the basis of the Polluter Pays and Provider Gets Principles.

We do this using two state-of-the-art agricultural economic simulation models. The first model, CAPRI, is used to quantify the large-scale or aggregate impacts for individual countries, the EU and the world. The other model, AgriPoliS, is used to quantify the fine-scale or farm and field level impacts in a selection of contrasting agricultural regions, to consider the potential influence of the large spatial variability in agricultural and environmental conditions across the EU.

The results show that direct payments are keeping more farms in the sector and more land in agricultural use than would otherwise be the case, and thus avoiding land abandonment, principally in marginal regions. Particularly the area of grassland is substantially higher, because it is generally less productive than arable land and hence more dependent on direct payments for keeping it in agricultural use. The magnitudes of the impacts of direct payments on land use therefore vary strongly across regions due to spatial variability in productivity: marginal regions with large areas of less productive land are heavily influenced by direct payments, while regions with large areas of relatively productive land are hardly affected, because this land would be farmed in any case.

By keeping more farmers in the sector longer, direct payments are slowing structural change, which can hamper agricultural development. However the potential benefits of faster structural change vary considerably among our study regions. In relatively productive regions direct payments are hindering development, because too many farmers are staying in the sector and preventing the consolidation of land in larger farms, which would improve their competitiveness and increase farm profits. On the contrary, the mass departure of farms that is currently avoided, will not lead to the same general benefits in marginal regions. Instead of freed land being absorbed by remaining farms, large areas of relatively unproductive land are abandoned without payments. This land is unprofitable to maintain in agricultural land use, even if integrated into larger farms, because current market prices are too low to motivate farming it. Consequently direct payments pose a serious goal conflict: the avoidance of land abandonment on the one hand, which can have negative impacts on public goods, and restricting agricultural development on the other hand. Once again this goal conflict is rooted in the spatial variability of agricultural conditions in the EU.

Maintaining extensively managed farmland, particularly semi-natural pastures, is central for conservation of biodiversity and preservation of the cultural landscape. Therefore direct payments are contributing to the provisioning of these public goods, but principally in marginal areas. Further, abandonment of land can reduce its agricultural productivity due to erosion or afforestation. Thus, direct payments are contributing to food security by preserving the productive potential of land for the future, but only marginal land since relatively productive land is farmed in any case.

Production of agricultural commodities is affected to a lesser degree by direct payments than land use per se. Nevertheless, food exports from the EU are higher and imports lower as a consequence of direct payments. However, the additional supply generated by direct payments also lowers output prices, which reduces the profitability of commodity production; thereby partially offsetting the additional revenues from direct payments.

The higher agricultural output brought about by direct payments causes higher levels of environmentally damaging greenhouse-gas emissions, nutrient surpluses and pesticide use. The higher greenhouse-gas emissions for the EU are, to some extent, moderated by lower emissions in the rest of the world. Nevertheless, the net effect of direct payments is higher global emissions of greenhouse gases.

The environmental impacts of higher nutrient surpluses and pesticide inputs are less conclusive, since these depend also on spatial factors, i.e., where the emissions occur. Although EU-scale and regional emissions are higher due to direct payments, agricultural production is less intensive generally, on account of the lower output prices. Analysing the net effects of these two opposing forces requires additional biophysical modelling at relevant spatial scales, such as watersheds or landscapes, which is beyond the scope of this study.

Pillar I direct payments generate a significant transfer of income to farmers and land owners who are not necessarily farmers; 40 billion euro annually. Of this transfer a substantial proportion goes to farmers in relatively productive regions and, further, to a minority of farmers that need them least. In relatively productive regions payments are not needed for continued agricultural production and preservation of farmland, but instead rather fuel higher land and rental prices, which hampers structural change. On the contrary, the need for support is greatest in marginal regions, because some form of payment to marginal land is needed to avoid its abandonment and the loss of associated public goods. Finally, the direct payments even come at the cost of lower market returns for farmers due to slower structural change (smaller and less competitive farms) and lower output prices (due to greater EU output). On the other hand the lower output prices lead to somewhat lower food prices, but at the greater cost of financing the direct payments.

Our main conclusion is that Pillar I direct payments are generating serious goal conflicts due to spatial variability in conditions across the EU. On the one hand these payments are contributing to the provisioning of public goods by preserving marginal agricultural land. On the other

hand they are hampering agricultural development, primarily in relatively productive regions. Payments to relatively productive land that would be farmed any way not only inflate land values (capitalisation) but also slow structural change, which are both likely to hinder agricultural development and hence the competitiveness of the EU on the global market. The direct payments also increase environmental pressure; by subsidising land use generally and the associated production, they are incapable of controlling environmentally damaging emissions, which is also in conflict with broad CAP objectives. The goal conflict arises because direct payments are universal, a payment principal that does not consider spatial variability in the EU and the associated trade-offs in regard to development and environmental effectiveness.

Our analysis considered two alternative policy instruments that have the potential to curb the identified goal conflicts associated with direct payments, by applying the Polluter Pays and Provider (of public goods) Gets Principles at appropriate spatial scales. Replacing direct payments with a payment targeted on marginal land (and associated public goods) prevents land abandonment at a lower cost, by avoiding payments to relatively productive land that is farmed in any case. This also allows surviving farms in regions with relatively productive land to compensate for lost direct payments through expansion and associated scale economies, as well as higher output prices. This instrument therefore finances the provisioning of public goods without adverse effects on development and the efficiency of agricultural production.

The EU-wide tax on mineral fertiliser demonstrates that this instrument has the potential to reduce nutrient surpluses. Since direct payments cause higher levels of polluting emissions, policy instruments targeting emissions at relevant spatial scales are needed to achieve cost-effective abatement.

Overall we find that Pillar I direct payments are not addressing the diversity of challenges facing European agriculture. In fact our quantitative analysis indicates that the potential for the current system to meet these challenges is seriously impaired by goal conflicts and spatial varia-

bility across the EU. A better policy requires that instruments are targeted on desired outcomes and designed according to sound principles, specifically the Polluter Pays and Provider Gets Principles. These principles would ensure that farmers are provided with appropriate incentives to i) generate public goods that otherwise would be underprovided; ii) mitigate environmentally damaging emissions at the lowest possible cost to society; and iii) continually strive to improve environmental performance. Such instruments are also fairer and promote a more competitive or viable agricultural sector by not obstructing structural change and hence agricultural development.

1 Introduction

European agriculture faces broad challenges. These challenges range from improving productivity and competitiveness to fostering income growth; provisioning of public goods like biodiversity, cultural landscapes and food security; and moving towards sustainable production by reducing agriculture´s contribution to environmental degradation and climate change. A central policy framework to address these challenges is the Common Agricultural Policy (CAP).

In the work mounting up to the CAP 2014-2020 reform, these challenges were clearly recognised, and the European Commission stated that the main CAP policy objectives for the future are viable food production, sustainable management of natural resources and climate action, as well as balanced territorial development (European Commission, 2013).

The challenges are all real and important. Also, the CAP objectives stated by the Commission are well aligned with them. However, despite the launch of some major reform elements, there is still a lack of consistency among the main CAP policy instruments and the stated objectives. Hence, there is still a lot of work to do in order to implement a more efficient and targeted policy framework, which is at the same time less complex for farmers and administrators, and more capable of achieving its core objectives.

The pros and cons of the current CAP set the stage for the post-2020 reform discussions. Some themes regarding the drawbacks of the current policy commonly surface in the ongoing discussions on the need for continued reform. These are, as pointed out by the (IEEP, 2014), the lack of justification for the current level and distribution of direct payments, the

lack of progress in delivering protection for biodiversity, water, soil, climate and cultural landscapes, and the inability of the CAP to help the sector to innovate and restructure in order to become more competitive and sustainable. In addition, the high complexity of the policy for farmers and administrators alike is a major concern.

Pillar I direct payments are a main feature of the current CAP, commanding almost three quarters of the total budget. As such, their construction and impacts are decisive for achieving the objectives stated by the Commission. An important part is the basic payment scheme which is granted to farmers based on the number of hectares farmed; thus the larger the farm the larger the payments received by the farmer. In addition, through a greening payment and cross-compliance conditions, the direct payments are intended to promote an environmentally sustainable agriculture.

In this report, we aim to analyse the economic and environmental impacts of the direct payments, and to demonstrate alternative instruments that are likely to better achieve the CAP objectives, using model simulations. In regard to economic impacts, we focus on the competitiveness of the EU agricultural sector and the potential for structural change to improve farm incomes. In terms of environmental impacts, we focus on the provisioning of public goods associated with farmland, i.e. conservation of biodiversity and cultural landscapes, and future food security; and mitigating agriculture's contribution to environmental change, particularly water pollution and climate change.

In a first step, we analyse the impacts of direct payments. Through comparing simulation results from a reference scenario with direct payments, to results from a counterfactual scenario without direct payments, in which the payments and associated conditions are removed, we are able to quantify the economic and environmental impacts of the payments. This exercise allows us to answer the questions as to what extent direct payments achieve their objectives, and the degree of goal conflicts, if any.

In a second step, we analyse the potential for achieving the multiple and potentially conflicting CAP objectives more efficiently using other instruments than direct payments. We apply one instrument targeting the provision of public goods according to the Provider Gets Principle (PGP), and one instrument targeting negative externalities according to the Polluter Pays Principle (PPP). In addition, the instruments target market failures and follow the principle of one instrument per objective.

In the public goods or PPP scenario, direct payments are replaced by payments linked to public goods via marginal, low-productive farmland. When direct payments were decoupled from production in the 2003 reform, a major concern was that marginal farmland would be abandoned. This could have negative impacts on public goods like food security and the environment if farmland is irrevocably lost; or if extensively farmed land that is important for biodiversity and the cultural landscape ceases to be managed with traditional practices such as grazing by ruminants. As a consequence, mandatory conditions requiring land to be kept in good agricultural and environmental condition (GAEC) were linked to the decoupled payments to prevent land deterioration or abandonment. Currently, farmers receive payments irrespective of whether their land is marginal or not. However, since productive land is unlikely to be abandoned some farmers receive a payment for doing something they are already rewarded for through the market for agricultural products. Under these conditions decoupled payments simply represent a transfer of wealth from taxpayers to landowners, i.e. an unnecessary payment because it does not contribute to CAP objectives.

So, in the public goods scenario, a new payment instrument is analysed that is geographically targeted to areas were land is at risk of abandonment without direct payments. The payment is intended to reflect the higher cost of managing marginal land and thus to compensate farmers for providing public goods typically associated with this land, thereby remedying the market failure whereby public goods are not adequately provided by market forces. In highly productive areas, farmers receive no payment because the land is profitable to farm under foreseeable market conditions. The payment analysed is not a final version of a new

instrument, but an effort to demonstrate the effects of geographically targeting payments to farmers. If such a payment was to be introduced in practice, deciding which land that would be eligible for support would be a crucial task. We do not delve into this issue in detail. Instead, for our illustrative purposes, marginal land is a sufficiently indicative criterion.

In the second alternative scenario, a targeted instrument that adheres to the Polluter Pays Principle is introduced. There are few such instruments available. We focus on the mitigation of environmentally damaging nutrient leaching and use an EU-wide tax on mineral fertilisers as an illustrative example. Although nutrient leaching is regionally important in for example the Baltic Sea region, there are other, severe environmental problems at the EU-level, were a PPP-based instrument could be an alternative. We do not, therefore, suggest any new instruments, but use what is known and available. The purpose is to analyse the impacts of a fertiliser tax per se, but also to investigate more generally this type of instrument in the context of the CAP.

It is essential to provide an overview of the total EU level impacts of the direct payments, but also to take into account how regional characteristics influence the outcome, as overall averages can hide substantial local variations of importance. To answer both questions using a single model is infeasible. We therefore use the CAPRI model for simulating consequences at the EU and national levels, and the AgriPoliS model for a more detailed regional case-study assessment based on individual farms and fields in a particular Member State, Sweden.

The results from the Swedish case-study are of interest in a broader perspective, as they indicate how different types of regions in the EU are affected by direct payments and alternative instruments. The study covers four typical Swedish regions with different farming systems, input intensities and shares of High Nature Value farmland. The characteristics of these regions are comparable to regions in other Member States, for example the intensive-cropping region in southern Sweden bears simi-

larities to north-eastern Germany, western France, the Danish peninsula and northern Austria.

Finally, we do not incorporate specific risk management or income support instruments into the analyses, as these aspects can, and need to be, analysed separately. Neither do we explore how Pillar II payment schemes can be improved. Hence, our objective is to evaluate a principal direction for reform for an important part of CAP; the Pillar I *direct payments* and associated conditions. We do not however intend to provide a blue-print for a new CAP, but hopefully identify some crucial issues for developing such a blue-print. Also, if direct payments were to be replaced by payments to marginal land, the new payment would command only part of the present direct payment envelope, leaving resources for additional targeted instruments to be employed. In addition, instruments like a fertiliser tax would generate additional revenues that could be used to finance complementary pollution abatement measures.

2 Objectives and instruments of the CAP

If a policy is to achieve its objectives, there must be a clear link between the problem at hand and the proposed remedy. An important question is whether instruments of the current CAP adequately address challenges faced by European agriculture, so that the CAP objectives can be achieved. Direct payments are the backbone of the current CAP, consuming almost three quarters of the total budget. The payments are principally an income support instrument based on the number of hectares a farmer manages.

In this chapter we focus on whether area-based direct payments can be expected to be an appropriate answer to each of the challenges ahead. Below, a presentation of the objectives and the structure of the CAP 2014-2020 are given, followed by a discussion of the potential links between payments and objectives. The possibility to improve the conditions linked to environmental performance, i.e. greening and cross-compliance are also discussed, as are general principles guiding economic policy formation.

2.1 CAP objectives

The CAP has several types of objectives. There are formal objectives outlined in the Rome Treaty, informal objectives that have evolved over time and become an integrated part of the policy, and, in the latest reform process, the Commission proposed three updated CAP objectives based on future challenges.

The formal and informal objectives

In the aftermaths of the Second World War and the ensuing food shortage, a main European concern was to achieve food-security and stable food prices. The Common Agricultural Policy (CAP) sprung from this general goal and according to article 39 of the Rome Treaty, the objectives of the CAP are to:

- increase agricultural productivity by modernising agricultural holdings,
- assure a fair standard of living for those engaged in agriculture,
- stabilise markets for agricultural products,
- ensure the availability of supplies, and
- ensure reasonable prices for consumers.

Over time, new challenges have arisen, leading to an enlarged set of stated yet informal objectives. Arguably the most central challenge, the damaging environmental impacts of intensive agriculture, was recognised in the early 1980s (Hodge et al., 2015). Focus has at the same time shifted from agriculture to the broader concept of rural development, while enlargement of the EU has simultaneously increased the diversity of agriculture and rural areas within the union. Despite these new concerns and changes in structure, the formal objectives set out in the Treaty remain the same.

Three long-term CAP objectives proposed by the Commission

In an effort to formulate objectives that address future challenges, the Commission propose three long-term objectives for the CAP (European Commission, 2013):

- viable food production,
- sustainable management of natural resources and climate action,
- balanced territorial development.

The objectives are based on economic, environmental and territorial challenges identified by the Commission. The challenges include, among others, declining productivity growth, loss of biodiversity and depopulation of rural areas; see Box 2.1 for an overview.

Box 2.1 Important challenges for European agriculture and rural areas

Economic	Food security and globalisation A declining rate of productivity growth Price volatility Pressure on production costs due to high input prices Deteriorating position of farmers in the food supply change
Environmental	Resource efficiency Soil and water quality Threats to habitats and biodiversity
Territorial	Rural areas are faced with demographic, economic and social developments including depopulation and relocation of business

Source: (European Commission, 2010, 2013)

To achieve these objectives, the Commission underscores that policy instruments need to be more efficient (European Commission, 2010). Consequently, for the CAP 2014-2020 reform, important objectives were improving agricultural competitiveness and environmental sustainability.

In the future reform process, the three objectives proposed by the Commission are central, as they relate to challenges for the future. In the analysis, we focus on the economic and environmental impacts of the CAP.

2.2 The CAP 2014-2020

The policy instruments to achieve the objectives presented above are divided into two pillars. The first pillar includes direct payments to farmers and market measures, and the second pillar holds the rural develop programmes. Instruments related to the environment are present in both

pillars; an important distinction is that Pillar I schemes are mandatory for farmers to fulfil, while Pillar II schemes are voluntary for farmers and includes compensation for costs incurred or income foregone.

The regulations guiding the direct payments are complex, but in order to better understand the simulation results later in the report, it is useful to have a grasp of the conditions a beneficiary must fulfil. Therefore, the presentation below centres on the structure of the direct payments.

Pillar I - Direct payments and market measures

The Pillar I direct payments form the backbone of the CAP; currently 72 per cent of the CAP budget goes to direct payments (European Commission, 2017). The payments are granted in the form of a per-hectare income support complemented with payments targeting specific objectives.

Box 2.2 The Basic Provisions in Regulation (EU) No 1307/2013

The Basic Provisions are:

- comply with the so called "minimum requirements",
- be active farmers, and
- have agricultural land at their disposal that is used in agricultural activity.

The *minimum requirements* indicate a lower threshold for the amount of direct support to be granted, or the size of the eligible land at hand, to avoid excessive administrative burden caused by managing small areas.

The *active farmer* provision excludes businesses/activities from payments which may hold some agricultural land but are not farms, such as airports and recreational areas.

Agricultural activity is defined as either production or maintaining agricultural land in a state which makes it suitable for grazing or cultivation (for example fallow land or set-aside). For arable land lying fallow and permanent grassland, most Member States have introduced requirements in terms of mowing the vegetation to avoid encroachment of woody plants (European Commission, 2016a).

Note: See European Commission (2016a) for a presentation of basic definitions, eligibility conditions and policy choices made by Member States regarding direct payments.

To be eligible for support, the farmer must fulfil the Basic Provisions of Regulation (EU) No 1307/2013 (EU, 2013) (see Box 2.2). A main implication of the provisions is that abandoned, overgrown farmland that cannot readily be used in production is not eligible for direct payments.

Further, farmers must hold a payment entitlement for each hectare of eligible land for which they claim direct payments. The entitlements were introduced as part of the 2003 reform, and distributed to farmers based on their eligible area according to historical data. Each Member State was free to set the total number of entitlements available in their country, though the countries' total payment budget was fixed. This has resulted in some Member States having more entitlements than eligible land, e.g. Sweden, and others having less. The implication is that in Member States where there is a scarcity of entitlements they will attract an economic value through the market for entitlements (Kilian and Salhofer, 2008). Overall, the entitlements can be bought and sold on an open market.

Farmers who fulfil the Basic Provisions and have payment entitlements, can access the direct payments by submitting a yearly aid application to the relevant national authority.

Farmers who are granted direct payments are subject to compulsory cross-compliance. These conditions are not eligibility conditions, but trigger penalties when not respected. Cross-compliance includes two elements. First, farmers must comply with legislation within the areas of the environment, public and animal health and welfare as stated in the *Statutory Management Requirements* (SMRs), and second, the farmland must be kept in *Good Agricultural and Environmental Condition* (GAEC). The GAEC conditions refer to a set of standards related to soil protection, maintenance of soil organic matter and structure, avoiding the deterioration of habitats, and water management, see Box 2.3. Cross-compliance thus integrates environmental requirements into Pillar I.

Box 2.3 Good Agricultural and Environmental Condition (GAEC).

Water	GAEC 1: Establishment of buffer strips along water courses
	GAEC 2: Where use of water for irrigation is subject to authorisation, compliance with authorisation procedures
	GAEC 3: Protection of ground water against pollution: prohibition of direct discharge into groundwater and measures to prevent indirect pollution of groundwater through discharge on the ground and percolation through the soil of dangerous substances
Soil and carbon stock	GAEC 4: Minimum soil cover
	GAEC 5: Minimum land management reflecting site specific conditions to limit erosion
	GAEC 6: Maintenance of soil organic matter through appropriate practices including ban on burning arable stubbles, except for plant health reasons
Landscape, minimum level of maintenance	GAEC 7: Retention of landscape features, including where appropriate, hedges, ponds, ditches, trees in line, in group or isolated, field margins and terraces, and including a ban on cutting hedges and trees during the bird breeding and rearing season and, as an option, measures for avoiding invasive plant species

Note: Avoiding encroachment of unwanted vegetation and protection of permanent pasture were part of the GAEC conditions in Regulation EC No 73/2009. Since the 2013 reform, these conditions are instead part of the Basic Provisions for being eligible for support in Regulation (EU) No 1307/2013. Source: Regulation (EU) No 1306/2013.

The two most important parts of the direct payment are the *Basic Payment Scheme* (BPS)[1] and the *Greening Payment (GP)*. The Basic Payment scheme replaces the Single Payment Scheme (SPS) from the 2003 reform. Like the Single Payment Scheme, the Basic Payment Scheme is a basic income support for farmers.

[1] For members that joined the EU in 2004 or 2007, the so called single area payment scheme is available instead of the standard direct payment schemes.

The greening payment is a new and mandatory component introduced with the 2013 reform. Strictly, the greening payment is not a new payment, but a new set of conditions that from 2015 applies to 30 per cent of the previous direct payments envelope (Regulation (EU) No 1307/2013) (EU, 2013). Hence, the 2013 reform introduced additional mandatory conditions linked to existing payments. The intention with the greening conditions is to promote practices that are good for the environment, soils and biodiversity in particular, and the global climate. The conditions are:

- maintaining permanent grassland,
- crop diversification, and
- establishing ecological focus areas of at least five per cent of the arable land of a holding.

Also, in the so called *Young Farmer Scheme,* Members States must allocate up to 2 per cent of their total direct payments to offer young farmers a bonus in their first five years working in the sector.

The basic payment scheme, the greening payment and the young farmer scheme are mandatory for Member States.

It is optional for Member States to use part of the direct payments for i) *Payments Coupled to Production* in sectors undergoing difficulties, ii) *Payments for Areas with Natural Constraints* such as mountain areas and iii) *Redistributive Payments* to support smaller farms. Finally, iv) a *Simplified Small Farmer Scheme* is available for very small farms. An overview of direct payments is given in Figure 2.1.

The Voluntary Coupled Support is a new instrument introduced in the 2013 reform. With the new support, Member States may link (couple) up to 13 per cent the direct payment envelope to specific products. The aim is to maintain the level of production in regions or sectors undergoing difficulties and that are of particular importance for economic, social or environmental reasons. Member States have made different choices re-

garding whether to use this opportunity, and for which sectors. The most supported sectors are beef and veal, and dairy products (European Commission, 2016b). It can be noted that the re-introduction of coupled support is a break in the trend towards greater market orientation of the CAP. Since the 2003 reform, the tendency has been to decouple all support from production; the idea is to let farmers decide what and how much to produce based on consumer demand rather than based on the structure of payments, thereby separating income support from the production decision.

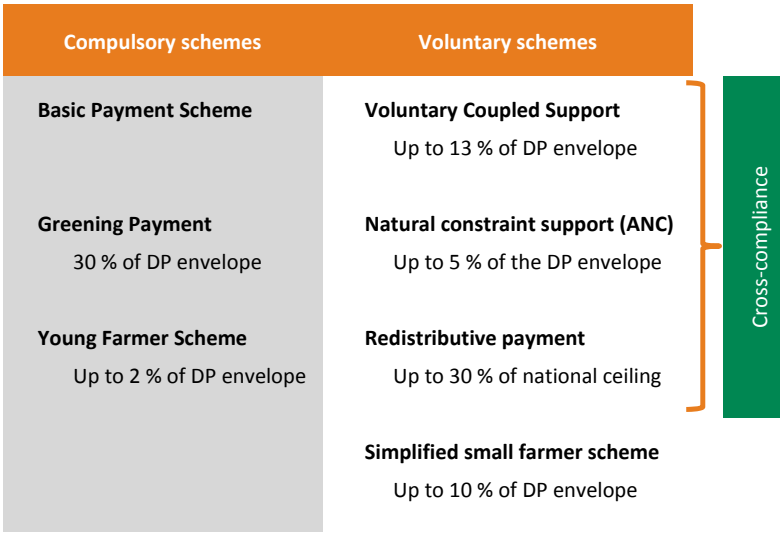


Figure 2.1 The structure of direct payments
Source: Based on (European Commission, 2017).

The second part of Pillar I consists of the market measures. The Common Market Organisation (CMO) sets out the parameters for intervention on agricultural markets, includes the rules for marketing agricultural products and covers issues related to international trade and rules of competition.

Pillar II - The Rural Development Programmes

The Rural Development Programmes (RDP) include measures intended to improve farmers' competitiveness, preserve the environment and enhance the quality of life in rural areas. Examples are support to farm investments, support to farmers who convert to organic farming practices, and support to establish or restore wetlands. Payments are also available for farmers in areas facing natural or other specific constraints.

The Pillar II *Agri-Environment Schemes* (AES) reward farmers for voluntary commitments to environmental measures beyond a baseline of legal obligations. Payment levels are differentiated according to costs incurred and income forgone, with the possibility of even paying for transaction costs. While Pillar I instruments are rather homogenous across farms and countries, Member States have more flexibility when developing a Rural Development Programme to suit national needs, by being able to choose between different priorities and associated instruments. In this study, neither the CMO nor the RDPs are changed in the analysis, i.e. they are kept constant in all simulations.

2.3 Consistency between objectives and direct payments

As discussed above, direct payments are aimed at two main objectives; i) a fair standard of living for those engaged in agriculture, by the intention to contribute to farm incomes and to limit income variability, and ii) environmentally sustainable agriculture through cross-compliance and the greening conditions. In addition, the Basic Provisions are intended to keep farmland not currently used in production available for potential future needs, thus linking the payments to food security.

Below, we discuss the links between direct payments and objectives, and whether the payments are an efficient means to fulfil them.[2]

Income support

The fair standard of living objective is commonly interpreted in terms of farm household income levels. In society at large, income support is giv-

[2] A more extensive discussion can be found in for example Buckwell et al. (2017), Matthews (2016), and Tangermann (2011).

en for equity reasons to those in need, based on household income. However, farmers as a group are not found to have lower incomes than society at large. For instance Hill and Bradley (2015) show that the average disposable household income where farming is the main income source, are similar to income levels in general within society.[3] Further, most support goes to farmers with large farms in high yielding areas with incomes above national averages, see for example (OECD, 2011). This structure is a legacy from the reforms of the 1990s and 2000s when the compensatory direct payments were introduced; large and productive farms lost the most from the reductions in price support and thus received the most compensation in terms of high direct payments (Cunha and Swinbank, 2011). Efforts have been made to reduce this skewness, but the most recent report on the distribution of payments show that 80 per cent of the payments still go to 20 per cent of the farmers (Matthews, 2017) based on (DG AGRI, 2016). Hence, direct payments are poorly targeted to low income farm households.

Another problem is that part of the payments leak to land-owners that may not be farmers, so called capitalisation. The reason is that the payments are linked to a scarce resource, farmland. Although farmers receive the payments, they compete with each other for access to land. For farmers that rent their land, part of the payments is invariably paid in higher rents to the landowner, particularly in relatively productive regions. For farmers who own their land, the payments inflate land values so that it becomes more expensive to buy additional land and more difficult for an heir to continue the farm if siblings are to be bought out. It also becomes more costly for potential farmers without land to enter the sector. Thus, the initial benefits of direct payments are partly off-set by an evolving higher cost structure for farmers over time.

Further, direct payments may influence the entry, exit and growth of farms (Brady et al., 2017). The higher cost structure makes expansion more costly, while the payments can make it easier for low profit farms to remain in the sector. Structural change, where competitive farms grow

[3] They emphasise for example that many farmers have extra income sources in addition to agriculture, sources which need to be taken into account when total income is calculated.

and low-productive farms exit, is important for the long term competitiveness of the sector. Hence, direct payments can have unintended negative effects on competitiveness and the renewal of the sector. This is harmful as market revenues are the main source of farm incomes.

Regarding efficiency and productivity, direct payments could have either positive or negative effects. For instance, it is possible that farmers with a high share of support face less incentive to be cost-efficient or to keep technologies up to date (OECD, 2011). Also, if too many farmers remain in the sector too long, it will limit access to additional land which is usually necessary to motivate costly new investments in larger and hence time-saving machinery or stables. If that is the case, support may foster continued dependence on support. On the other hand, direct payments may provide the means for efficiency-enhancing investments and innovations. However, there is investment support available in Pillar II as an alternative source of funding.

Altogether, it is generally argued that direct payments are a poor income support instrument.

Income stabilisation

Fluctuations in prices and produced quantities cause volatility in farm incomes. This, in turn, may reduce incentives to engage in farming and invest in new technology and knowledge. It has been claimed that the direct payments reduce the income risk in farming as they provide a stable source of income complementing market revenues (Severini et al., 2016).

However, as pointed out by Mahé and Bureau (2016) direct payments provide an income floor. Above this floor, incomes fluctuate in response to price and yield disturbances much as they would have done without the floor; the floor raises the mean income, but this does not change the probability of losing a given amount. Accordingly, the direct payments do not stabilise farm income. Instead, all farmers receive payments in all years irrespective of whether prices are high or low, or whether the specific sector they are active in is more susceptible to risks than other sec-

tors (Buckwell et al., 2017; Fresco and Poppe, 2016). A more targeted risk instrument is thus needed to cope with market instabilities, see for example the discussion in Cordier (2014).

Food and nutrition security

It is often argued that direct payments are needed to secure food for EU citizens at affordable prices and to satisfying global food demand. For non-member countries with poor food security, expanded food production in the EU is not a solution, as pointed out by for example Bureau and Swinnen (2017). A more viable strategy for these countries is to try to overcome poverty, the major source of food deficiency, and such efforts may be harmed by excess supported food production in other parts of the world as it undermines their own food production.

For Member States, there is presently no shortage of supply and food prices are low in relation to incomes in the EU (Matthews, 2017). However, direct payments, being decoupled from production, are currently not the most important explanation for this situation. Instead, technological development and opportunities to utilise comparative advantages through international trade have been more instrumental in lowering food prices. The food insecurity still present in the EU is a function of low purchasing power in poor households, not lack of food production in the EU. For those households, targeted public expenditures are needed, rather than incentives to increase the domestic production of food.

International trade is important for taking care of potential shocks to food supply. If one source faces difficulties due to unfavourable weather, diseases or political disturbances, there are other sources to choose from. Relying entirely on domestic production could instead lead to increased risks; for instance the EU's agricultural sector is dependent on imported inputs without which production would be severely limited (Gullstrand and Jörgensen, 2018). Therefore, low barriers to trade are important for national, as well as world-wide, food security.

A problem with international trade is that a major logistic interruption, such as export-embargos or war, could pose a temporary threat to EU

food imports. However, approximately 20 per cent of the food produced within the EU is currently wasted (Stenmarck et al., 2016). Also, a major share of the grains cultivated in the EU is under normal circumstances fed to livestock, creating a large reserve of protein that could instead be directly consumed by humans. Hence, there is substantial room to adjust consumption patterns and use domestic production more effectively, if needed.

However, one of the most important assets for the future from a food security perspective is the *capacity* to produce. A potential threat is the degradation of agricultural land and water resources. Another threat is the conversion of agricultural land to other uses. For example, afforestation and urban development claim agricultural land that cannot be easily restored if the need arises in the future. Also, low market prices today may cause abandonment of low-yielding land that could be needed and profitable in the future. There is, therefore, a need to have efficient agri-environment instruments in place to promote an environmentally sustainable agriculture, and it may also be prudent to keep agricultural land in productive condition for potential future needs. Farmers cannot be expected to incur the costs of preserving land that is currently unprofitable to cultivate for future use without some remuneration.[4] However, it is unlikely that the most efficient way to do this is through direct payments to all agricultural land in the EU.

Environmentally sustainable agriculture

Agriculture has pervasive impacts on environmental quality in the EU; both negative impacts in the form of polluting emissions and degradation of soils and habitat, and in special cases profoundly positive impacts through its contribution to conserving biodiversity and cultural landscapes (EEA, 2006). This is because agriculture is a major land use generally and a dominating land use in many regions.

[4] See for example Molander (1988) who argue that food security as such is a public good. It is for example unlikely that a remuneration for unprofitable land can be obtained on the market as it would be difficult and costly to exclude persons that have not paid for the preservation of the land from the possibility to consume the food produced on it, thus the future capacity to produce food is a public good.

Box 2.4 Environmental challenges for European agriculture.

Water quality	Nonpoint-source pollution resulting from application of fertilisers and chemicals to crops is a major cause of impaired ground and surface water quality by agriculture. A particular problem is the enrichment of surface water with nutrients that for instance causes eutrophication and ultimately sea bottoms devoid of life. The Baltic Sea suffers from recurrent algae blooms driven by excessive nutrient loadings.
Climate change	Agriculture is both affected by and a major contributor to climate change. Climate change is expected to negatively impact European agriculture, due to increasing temperature variations, water scarcity, fire risks and incidences of diseases. Agriculture emits large amounts of nitrous oxide and methane to the atmosphere, which contribute to around 11 per cent of Europe's total greenhouse gas (GHG) emissions. Nitrous oxides are emitted through the application of mineral fertilisers and manure on susceptible soils. Methane is largely emitted by ruminants as a natural part of their digestive process.
Biodiversity	Intensification of agriculture and abandonment of traditional farming practices and farmland are main drivers of biodiversity decline in Europe. The problem has two dimensions. The first is the loss of unique, endangered species. Secondly, biodiversity, but not necessarily endangered species, provides ecosystem services that are essential for agricultural production and human welfare generally. An example is the services of pollinating insects. A loss of biodiversity also weakens the ecosystems' ability to moderate natural disasters, like floods and droughts, and human-induced stress, like climate change and pollution. The loss of ecosystem services is particularly a problem in intensively farmed arable regions.
Soil degradation and air pollution	The degradation of soil quality, both in the form of salinisation and erosion and through degradation of soil organic matter, compaction, and loss of soil biodiversity is a prominent problem. Air pollution, primarily through emissions of ammonia related to the handling, storage and use of livestock manure, is also problematic.
Cultural landscape	Almost all rural areas in Europe have been shaped by humans over eons and can be considered cultural landscapes. Maintaining agricultural activity, and often traditional practices such as grazing, is often necessary for preserving the cultural landscape. Losing marginal and traditional agriculture usually means losing valuable landscape features.

Intensively farmed land is usually characterised by highly productive soils which makes it economically rational to use high input application rates (i.e. quantity per ha), whereas low-productive or *marginal land* is optimally farmed extensively, i.e. with minimal inputs of chemicals and fertilisers, because the potential yield increases are not sufficient to motivate the additional costs of chemical and mineral inputs. For these reasons there is often a strong correlation between intensively farmed land and environmentally damaging emissions (e.g., specialised arable cropping); and between farming marginal land and the provisioning of public goods (e.g. grazing of semi-natural grasslands is necessary for conservation of biodiversity). For an overview of these environmental challenges see Box 2.4.

In the next section, we discuss to what extent cross-compliance and greening can tackle the environmental challenges faced by European agriculture. In addition, we also touch on and make a comparison with Pillar II agri-environment schemes.

2.4 The CAP and the environment

Currently, environmental concerns are addressed in two main ways in the CAP. Compulsory conditions for preserving environmental values are attached to Pillar I direct payments through cross-compliance and greening linked to direct payments, and voluntary engagement in environmentally friendly agricultural practices is rewarded through Pillar II Agri-Environment Schemes (AES). Below, we discuss the potential for greening, cross-compliance and Agri-Environment Schemes to promote sustainable agriculture and the delivery of public goods.

Greening

Greening was introduced in the 2013 CAP reform and intended to incentivise more environmentally friendly land management. Greening was supposed to consist of "*simple, generalised, non-contractual, annual environmental measures that goes beyond cross-compliance*" (European Commission, 2011b). The Commission envisaged that "*these measures will cover the whole EU territory, will be defined as uniformly as possible, and all farmers will get the same payment per ha corresponding to the share of direct*

payments". Moreover, the Commission argued that "*… it will be essential to provide for uniform application within and across MS thus ensuring equal treatment for all farmers and a strong impact on the environment and climate change*"(European Commission, 2011b).

The idea of a simple system applicable to the whole territory of the Union and, hence, delivering substantial environmental benefits appears *prima facie* to be very attractive but it is actually a weak or implausible idea. Due to the vast diversity of agronomic, environmental and economic conditions across the EU, it is impossible to design a set of simple rules that are universally applicable to the whole territory. Efficient environmental management requires place-specific adjustment, or spatial targeting, which is the diametric opposite to universal rules. The outcome of the 2013 reform, with respect to greening, is therefore a set of very complicated rules, subject to discretionary implementation on particular details by individual Member States, while administrative and control costs are high.

The environmental benefits of greening are further likely to be very limited, see for example Hart et al. (2016). A large share of the land and the farmers are exempted from greening requirements (Hart, 2015), while the requirements have led to minimal changes in land use (Söderberg, 2016). Analyses of the implementation of greening at the national level indicate that national politicians focused on avoiding negative economic impact on farmers rather than on achieving positive environmental effects (Hart, 2015).

Choices made by farmers follow the same pattern, which again is not surprising. The green payment is fixed in advance regardless of the cost of actual actions taken. Accordingly, it is rational for a farmer to minimise costs for obtaining this payment by choosing the cheapest options from the menu of eligible measures available at the national level. In the process, the environmental concerns are lost. For example, Pe'er et al. (2017) show that EFA measures that ecologists suggest to be the most beneficial from an environmental perspective are not the same as those that farmers prefer to adopt. Finally, the environmental outcome of

greening appears especially meagre in relation to the costs, since Greening Payment command twice the funding of the rural development measures devoted to environment and climate (Buckwell et al., 2017).

Cross-compliance

Cross-compliance is linked to existing environmental legislation through the *Statutory Management Requirements* (SMR). The official motivation behind the introduction of cross-compliance was not to substitute for the legal obligations for farmers to follow the SMR or for the MS's obligation to implement a management, control and sanction system. Instead, by creating "*higher financial risk*" farmers' "*awareness of their legal obligation"* was supposed to be raised (European Commission, 2011a). One can assume that cross-compliance was introduced because of unsatisfactory implementation of EU legislation (Nitsch and Osterburg, 2007). It is reasonable to assume that the higher financial risk due to the introduction of cross-compliance has resulted in improved environmental performance of agriculture. However, it could be argued that the positive effect is due to the inappropriate working of the legal system(s), which should have ensured that laws are followed.

Introduction of cross-compliance was accompanied by decoupling of direct payments from production, which had been feared to result in abandonment of marginal land. Studies indicate that marginal land, often pastures, would be abandoned if no activity is required or payment ceased (Renwick et al., 2013; Söderberg, 2016). The intentions behind the conditions linked to *Good Agricultural and Environmental Condition* (*GAEC)* were, accordingly, to prevent marginal land from being abandoned and keep productive land in good condition, implying that GAEC in combination with direct payments contributed to keeping land in agricultural use. Since 2013, having eligible land is part of the Basic Provisions farmers must meet to be eligible for payments according to regulation EU 1307/2113. Hence, the role of GAEC has been taken over by this regulation. Since abandonment of marginal land would have serious implications for conservation of biodiversity, cultural landscapes and future production potential in view of climate change, the regulation in combination with direct payments is expected to contribute to the deliv-

ery of the public goods in question. Through its additional requirements, GAEC could be contributing to higher quality of land management on all land.

Pillar II Agri-Environment Schemes (AES)

Agri-Environment Schemes (AES) reward farmers for specific environmental actions. They support voluntary commitments beyond a baseline of legal obligations by farmers and other land managers, undertaken for a minimum period of at least five years. Payment levels are differentiated according to costs incurred and income forgone with the possibility of paying for transaction costs in addition. Rewarding providers of public goods with payments based on costs incurred or income forgone is a sound principle that follows the Provider Gets Principle. Further, place-specific adjustment is essential for designing efficient remedies of environmental problems, and Agri-Environment Schemes can be tailored to the local situation.

The actual implementation of Agri-Environment Schemes has been criticised, though, for not always delivering tangible environmental benefits due to vague objectives and not enough demanding obligations within some of the schemes, see for example European Court of Auditors (2011). A major disadvantage of Agri-Environment Schemes often mentioned is their low uptake in intensely farmed regions, which is due to the high opportunity costs in these regions and voluntary nature of the schemes.

Thus, initial evidence suggests that the environmental benefits from greening are likely to be limited, that SMR may have a positive impact on the environment if farmers do not follow the law without the threat of losing support, and that the GAEC and the Basic Provisions may have a positive impact by preserving marginal land, which could be positive for public goods. Agri-Environment Schemes are in principle a sound policy but do not always deliver in accordance with their potential.

Can greening, cross-compliance and Agri-Environment Schemes be improved?

Would it be possible to boost the performance of the present system by improving its components, i.e. through improved greening, cross-compliance and AES?

The issue of an improvement of cross-compliance can be discussed from both a pragmatic and a principal point of view. Several suggestions have been advanced on how to make the rules more reasonable and clear, see for instance (Hart et al., 2016). However, from a theoretical point of view, it could be argued that the underlying principles are flawed.

Introduction of cross-compliance implied, in case of the SMR, the linking of pre-existing direct payments with pre-existing environmental (and other) regulations. Accordingly, the argument goes, payments cannot be seen as a remuneration for obeying the law. However, cross-compliance was introduced *because* of insufficient law obedience and seems at present to play an important role for upholding the law. In so far as payments are essential for upholding the law, it could be argued that farmers are, at least to some extent, paid for law obedience. This could be seen as a contradiction of the Polluter Pays Principle explained in Box 2.5. Comparable approaches to law obedience do not exist in other sectors of the economy. Recipients of general income support such as social welfare payments or child allowances face legal consequences for breaching rules or committing crimes but do not risk double penalties. Instead, rather than linking laws to direct payments, the incentives to obey the laws *per se* must be strengthened or rather restored. This includes attention to both the level of penalties and frequency of controls.

Several suggestions have been made on how to improve the Greening Payment. For example Hart et al. (2016), identify introduction of more demanding measures, especially for ecological focus areas (EFAs), withdrawal of measures that add little environmental value and paying greater attention to environmental outcomes. Improving the Greening Payment must entail an assurance of a higher delivery of environmental benefits. In reality it should imply better adjustment of environmental

measures to the local circumstances and better aligning the Greening Payment with the actual costs of the environmental actions. However, this would make the Greening Payment more similar to AES, thus becoming a kind of compulsory but more generously rewarded AES.

Improving Agri-Environment Schemes has two major concerns: better territorial coverage and improvement of environmental performance. The uptake of Agri-Environment Schemes differs between regions, indicating that payments do not reflect the true variation of opportunity costs of engaging in activities benefitting the environment across regions. A possible remedy is to offer higher payments in locations where environmental problems are severe but uptake of Agri-Environment Schemes is low. Also, a consistent application of the Provider Gets Principle (Box 2.5), according to which farmers are compensated for additional costs incurred and/or income forgone, implies that there is no need for dividing measures and payments into "tiers" as often suggested in various reform proposals, see for instance Buckwell et al. (2017). If the principle is strictly followed, higher costs translate automatically to higher payments.

Further, Agri-Environment Schemes would need to focus more strongly on desired environmental outcomes. Paying for a result and not for an effort is a promising way forward. Interest in result-oriented payments has grown steadily in Europe, see for example Burton and Schwarz (2013). A transfer from action-based to result-oriented schemes on a massive scale is, probably, not realistic in the short run. However, even within action-based systems the focus on results could be strengthened. Improvement of Agri-Environment Schemes is to a large extent up to Member States. At the EU level, a stronger demand could be made on Member States to clearly demonstrate, by using appropriate scientific methodology, that the schemes are actually delivering improvements. Moreover, experiences from the compulsory policy evaluations and the knowledge generated in that process could be exchanged between Member States and inform design of more efficient policies.

To conclude, the analysis in this section indicates that the potential for a substantial improvement in environmental performance of the present system is very limited, with exception of Agri-Environment Schemes which are in principle soundly designed but where the design and implementation can be improved. Cross-compliance and greening are, on the other hand based on flawed principles and an overhaul of the underlying logic is needed. In the next section, we discuss how such an overhaul could be designed.

2.5 A better policy – key features

The preceding qualitative analysis indicates that the direct payments fail to deliver on many CAP objectives including income support, risk management and environmental sustainability and the provisioning of public goods. [5] One exception is that the payments very likely contribute to conservation of biodiversity and cultural landscapes by preserving marginal agricultural land. One alternative is to reform direct payment to focus on the delivery of public goods linked to the preservation of marginal land, and to address other objectives with more targeted instruments. Such a change would be in line with general economic principles for policy design, principles that are presented below.

Market failures as a rationale for policy intervention

In market economies, the private sector is the core producer of goods and services. A main rationale for public intervention (policy) is when markets fail, see for example Stiglitz (2000). Market failures relevant to European agriculture are the i) presence of public goods, that is goods or services that are not provided at all or in an insufficient amount by market forces alone, and ii) externalities, which are actions of an individual/firm that affect others and impose a cost (or benefit) on them without compensation. Examples of important public goods associated with agriculture are farmland biodiversity, cultural landscapes, farm animal welfare and food security (Hart et al., 2011). Another example is new

[5] This is in agreement with several other assessments of the merits of the present CAP. Many researchers, organisations and NGOs commonly argue that a major reform of the direct payments is needed (see for example Buckwell et al. (2017), Matthews (2016, 2017), OECD (2011), Tangermann (2011), and WWF (2010).

knowledge and innovations. Examples of negative externalities are water pollution and emissions of greenhouse gases.

An additional rationale for policy intervention is equity (Stiglitz, 2000). Policy makers may wish to affect the distribution of income among citizens. Usually this is covered by national social policies.

General principles for an efficient environmental policy

A general principle for efficient policy design is *one instrument for each objective* (Tinbergen, 1952, 1956). The CAP has many objectives and hence these cannot all be achieved with few instruments. Achieving two objectives, income and environment, which are the centre pieces of the CAP, demands at least two instruments unless the objectives are well correlated, which they are obviously not. For that reason, attaching environmental requirements to pre-existing direct payments designed to support income, as it has been done in the present CAP, is questionable.

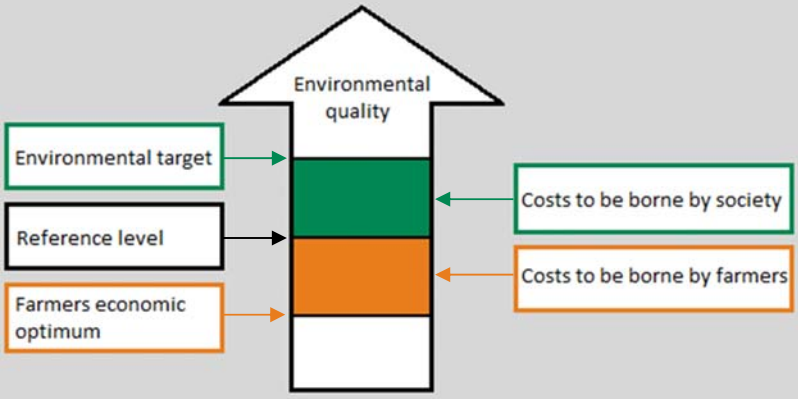
Further, the *Polluter Pays Principle* (PPP) and the *Provider Gets Principle* (PGP) are fundamental principles governing relations between an economic activity and the society at large, see Box 2.5. The introduction of environmental concerns into the CAP has evolved into a complicated system with unclear boundaries as to what farmers are expected to do without compensation and what they are supposed to receive support for. The legitimacy of environmental payments as well as the design of such payments would be substantially enhanced if they were based on consistent applications of the PPP and the PGP.

The present CAP does not fully adhere to the two principles with exception of the AES, which follow the PGP by the virtue of their design as they are based on payments for additional costs/income forgone. However, in cases, when farmers are paid for some actions aimed at reducing nutrient leakage, such as construction of wetlands or other negative effects, it could be argued that farmers should be obliged to take appropriate actions without an additional remuneration.

Greening must be deemed as highly questionable from the point of view of paying a reasonable remuneration for provision of societal benefits, i.e. the PGP. There is no direct link between the payment, fixed in advance, and the cost of the actions required to obtain that payment or the environmental benefits the actions deliver. In some cases, very little additional effort, if any, is needed to obtain the payment, since previously existing land uses for example can qualify as Ecological Focus Areas.

Box 2.5 The Polluter Pays and the Provider Gets Principles

The Provider Gets Principle (PGP) implies that producers are fully rewarded for the provision of societal benefits that require additional effort or economic sacrifice. In case of agriculture, PGP implies remunerating farmers for delivering public goods that otherwise would not be produced. Agricultural activities may also have negative impacts on the environment. In such cases, agricultural producers are to be held responsible for the environmental damage they cause; that is the Polluter Pays Principle (PPP). The interaction between the principles is illustrated in the figure.



Source: Based on (OECD, 2010).

A reference level defines what society at a given point in time considers an acceptable level of the environmental state. Hence, the reference level in the figure is defined by existing regulations and environmental laws. According to the PPP, farmers should be obliged to follow environmental regulations without additional payments. Any violation of them is to be treated with a fine proportional to the extent and severity of the damage incurred. Costs of any action beyond those required by the reference level are to be borne by society, i.e. farmers are rewarded according to the PGP.

Instruments to mitigate agriculture's negative effects on the environment need to be considered if the Polluter Pays Principle is truly to be applied to agriculture; an example is a tax on mineral fertilisers. At present, farmers are paid, through AES, for various mitigation actions, for instance buffer strips or creation of wetlands, to reduce the consequences of nutrient surpluses. These policies are highly motivated but could, for example, be complemented by the taxation of the source of surpluses. A tax on mineral fertiliser is an example of levying the societal cost of environmental damage from nutrient surpluses, a negative externality, on the polluter, i.e. farmers. The level of the tax should be sufficient to induce farmers to reduce surpluses, and in combination with other instruments achieve societally acceptable levels of pollution.

To conclude, a more efficient policy framework should be guided by the following principles: one instrument per objective, targeting of market failures and instruments based on the Provider Gets and the Polluter Pays Principles. In the following chapters, the impacts of direct payments and instruments following these principles are analysed for both the EU as a whole and in more detail for a selection of contrasting regions in Sweden.

3 Method

The purpose of this report is to analyse the economic and environmental impacts of Pillar I direct payments, and to demonstrate other instruments that may be more efficient tools for meeting CAP objectives. We approach this by simulating a series of scenarios. First we compare a situation *with* Pillar I direct payments to a situation *without* such payments in order to determine the impacts of direct payments. Subsequently we test new policy instruments instead of direct payments that are more closely targeted on CAP objectives. To do this we use two agricultural economic simulation models, CAPRI and AgriPoliS.

We begin this chapter by providing an overview of model simulations as a method for policy analysis, followed by a description of the policy scenarios and relevant indicators we simulate, and finally provide an introduction to the CAPRI and AgriPoliS models

3.1 Using simulation models for analysing policy impacts

The CAPRI and AgriPoliS models simulate, respectively, the response of the entire agricultural sector or a particular study region and population of individual farms to a policy change, by simulating the behaviour of and interactions among relevant economic agents, given the economic, technological and environmental context they operate in. By introducing a change in the model and comparing the results to those of a scenario where no change is made, the effects of the change in policy can be predicted. For example, new instruments can be added and compared to a situation without those instruments, and policy instruments already present can be removed and their impacts quantified.

The flow chart in Figure 3.1 provides a conceptual picture of the process of change that is modelled in this analysis. The process begins with the

policy instruments and ends in the effects on the environmental and economic indicators that are the focus of this report.

Economic simulation models serve as laboratories for economic research, allowing us to carry out experiments that are impossible to execute in reality. The models give precise results, but, it should be kept in mind that they rely on assumptions (for instance that producers maximise profits and that consumers maximise utility) and the utilisation of model parameters (for instance supply and demand elasticities in CAPRI). Hence, the precise results should be interpreted with caution; it is more meaningful to compare broader differences between scenarios, than decimal points.

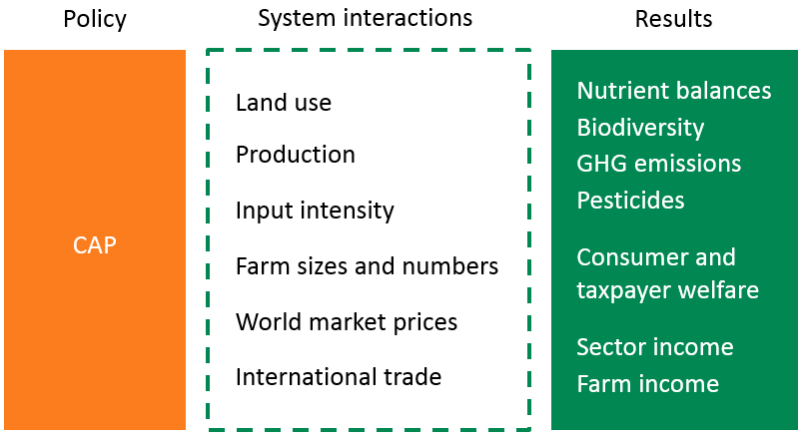


Figure 3.1 A conceptual illustration of the impacts of the Common Agricultural Policy.

CAPRI simulates agriculture at the aggregate level and for the entire EU, whereas AgriPoliS simulates regional agricultural development in a selection of relatively small regions. It is well known that one model cannot generally answer all questions; rather the choice of model should be dictated by the question at hand. CAPRI is suitable for answering questions about the general impacts of a policy instrument for the entire EU at relatively high regional levels of aggregation, and for capturing potential impacts on global production and markets. AgriPoliS on the other

hand models agricultural production in much greater detail, i.e. at the farm and field levels considering local conditions; a degree of detail which is not practical to model for the entire EU. Hence both models represent trade-offs between coverage (scale) and detail, but in opposing directions thus complementing each other. By running the models in parallel and using, in principal, identical policy scenarios, we can draw conclusions both on what the large-scale effects of a policy instrument are likely to be, and identify important variations in regional and even local outcomes.

In the Swedish case study, four typical regions are modelled. By considering key agricultural and environmental indicators and central determinants of variation in outcomes, we can draw parallels between regions in Sweden and other regions in the EU. Hence, the results for Sweden are of interest also in a broader European context, by indicating how comparable regions can be expected to be affected (see Box 3.3 in section 3.5).

3.2 Policy scenarios

Our analysis is based on simulation of four policy scenarios in the CAPRI and AgriPoliS models. We begin with two scenarios that we use to analyse the impact of the current Pillar I direct payments on European agriculture and the environment; one scenario replicating the current policy in which the payments are part of the CAP (REF), and one in which they are not (NO DIRECT PAYMENTS). The two final scenarios are used to explore two additional policy instruments that are applications of the Provider Gets and Polluter Pays Principles that were discussed in Box 2.5. Our purpose with these additional scenarios is to demonstrate that there are alternative, possibly more efficient, ways of reaching CAP objectives. The specific instruments we model are examples of such and should not be interpreted as proposals for a new, optimised CAP. Key aspects of the scenarios are summarised in Box 3.1.

Box 3.1 Simulation scenarios

With direct payments (REF)	The current policy, the CAP 2014-2020, is continued and unchanged through 2020-2025. The country-specific policies, such as greening conditions and Voluntary Coupled Support (VCS), are included. See chapter 2 for a description of the current CAP.
Without direct payments (NO DIRECT PAYMENTS)	A policy *without* the Pillar I direct payments is simulated through 2020-2025. There are hence no basic payment scheme, no Greening Payment, support to young farmers or Voluntary Coupled Support in the policy, nor any Basic Provisions, GAEC or conditions for the Greening Payment. The SMR that are included in the models still apply. Pillar II payments (ANC, AES), market measures and national systems also remain unchanged. As member states have made different policy decisions regarding voluntary measures, the impacts of direct payments will also be affected by interactions with other payments. These are described in the results sections.[6]
Environmental payments for marginal land (PUBLIC GOODS)	A payment for marginal agricultural land amounting to the member state average Pillar I direct payments is combined with the NO DIRECT PAYMENTS scenario.[7] For marginal land, the per-hectare payment is very similar to the amounts in REF. This instrument is designed to keep marginal land in good agricultural condition, thereby contributing to the food security objective and to preserve biodiversity and cultural landscapes. These impacts are examples of public goods where market forces cannot be expected to generate a societal optimum. The payment is conditioned on fulfilling the Basic Provisions and GAEC.
Fertiliser tax (TAX)	A nutrient tax on mineral fertilisers (nitrogen and phosphorus content) of 25% is combined with the NO DIRECT PAYMENTS scenario.[8] This instrument is designed to reduce the use of mineral fertilisers and thereby reduce nutrient leaching, and hence contributing to the water quality objective. Nutrient leaching is a problem that markets alone do not address to an optimal extent. This scenario is only simulated in CAPRI.

[6] There is room for the Member States to allocate the national envelope somewhat differently between Pillar I and Pillar II. As the allocation differs, and some Member States have additional national schemes (e.g. the Nordic Aid scheme), the size of the payments that are removed, both in absolute terms and as a share of the total Pillar I support, will differ between countries. Only the support to agriculture in Pillar II is modelled, not Pillar II support targeting non-agricultural activities.

[7] The average support per hectare of agricultural land in a country, including any VCS support.

[8] A tax of 25% was selected as it was the average level of the Swedish nitrate tax that was used in 1995-2009 (Swedish Agency for Public Management, 2011). Note, this tax rate has not been chosen on grounds of efficiency.

In the model simulations, the payment in the PUBLIC GOODS scenario is spatially targeted but otherwise identical in structure to the Pillar I Basic Payment. The reason for this approach is to isolate the main feature of the new payment; some farm land receives payment while some farm land receives no payment, all other things being equal. This is the principal aspect to be analysed. The indicator we use to decide if land receives payment or not is whether land is marginal or the production extensive, depending on model. In reality, a payment to promote the provision of public goods would probably be designed in a different manner regarding coverage, conditions etc. compared to the modelled payment. However, the underlying *principle* would be the same, and thus this structure is sufficient for the analysis. Further, if we change many parameters at the same time, like conditions, support levels, pillar-structure etc., those changes could obscure the effects of spatially targeting the payment. More work is needed to decide how such a payment could be optimally designed and implemented in reality. For example, that land is classified as an Area with Natural Constraints is probably not a sufficient condition for the provision of public goods. In the simulations a rather substantial area is covered by the payment while, in reality, a much smaller share of agricultural land is likely to be eligible.

We have aspired to use equivalent policy scenarios in both models. Since the models differ, the implementation of the scenarios also has to be slightly different, in particular the implementation of the payment for marginal land in the PUBLIC GOODS scenario. The implementation of the payment in the respective model is described in Box 3.2.

Finally, it is useful to keep in mind that we do not analyse the *change* in our indicators over the period 2020-2025. What we analyse is the *differences* in our indicators between the scenarios in 2025. That is to say, we wish to identify and compare the impacts of the current CAP with those of the alternative policies in 2025. When we describe impacts in relative terms such as an “increase” or a “decrease”, the comparison is therefore to the REF scenario in 2025.

Box 3.2 Modelling eligibility for the payment for marginal land

In **CAPRI**, we distinguish only two types of land: arable land and grassland. Each of these classes is homogeneous within regions, implying that there is no such thing as LFA land or marginal land that can easily be targeted for the payment. There is an increasing cost of using more land, which makes the model react as if land were heterogeneous, but there is no explicit allocation of crops to particular hectares in space. In order to simulate the PUBLIC GOODS payment in CAPRI without the differentiation of land, we make use of the *alternative production technologies* that exist for crops in the model. In simulations, each crop is split: 50% into a higher yielding, higher input technology and 50% into a lower yielding, lower input technology. This is done in a standard way for all regions, and the intention is to better reflect the fact that some farmers in some areas (within a NUTS2-region) produce at higher intensity than others, and to allow the intensity of production to change in response to changing economic incentives, such as higher crop prices or a tax on fertilisers. We call the technologies *extensive* and *intensive.*

In order to target LFA areas to simulate the public-goods payment, we assume that more extensive technologies are dominating in LFA areas. We therefore allocate the new payment first to the 50% using extensive technology. Now, the likelihood that a region has very close to a 50% LFA share, corresponding neatly with our extensive technology, is small. If the share of LFA is smaller than 50%, then the entire extensive but none of the intensive technology is eligible, and the amount per hectare is set so that the total spending in the region corresponds to the share of LFA. If the LFA share is higher than 50%, then some intensive production is also supported, but at a lower level, according to the LFA share. If the share of LFA is for example 75%, all of the extensive technology (50% of the total) and half of the intensive technology (25% of the total), is interpreted as LFA.

The implementation of the PUBLIC GOODS payment in CAPRI implies that it is not truly a payment to particular land areas, but rather a subsidy to more extensive forms of land use. Introducing the payment will induce farmers to take up extensive production. The budget for the payment is fixed per region (the LFA-area times the nominal amount per ha), so if the use of extensive technologies increases, the average payment per hectare is reduced. Furthermore, since land itself is homogeneous, the subsidy will induce farmers to move away from non-supported intensive technologies. As a result, land use will expand.

AgriPoliS features a high spatial resolution, with heterogeneous land quality within regions, modelling individual plots with consideration of their spatial location and biophysical characteristics. The support to marginal land in the PUBLIC GOODS scenario can therefore be targeted in AgriPoliS, resulting in some payments being made also to marginal land in non-LFA regions where the land has the appropriate biophysical characteristics. The two low-productive regions in AgriPoliS are entirely made up of eligible land, whereas the high-productive regions have comparatively few or very few eligible hectares.

3.3 Indicators

The two models combined compute a large number of indicators for agricultural production, economic performance and environmental impacts. Table 3.1 and Table 3.2 list the key indicators used in this analysis and how they are computed.

Table 3.1 Computation of environmental indicators.

	CAPRI	AgriPoliS
Nutrient balances	The difference between nutrients added to fields and removals by harvests; i.e. a soil-surface model is applied.	The difference between nutrients imported to the farm and removed through exports of outputs; i.e. a farm-gate model is applied.
Biodiversity	Not applicable.	Computed using a species-area relationship based on inventories of red-listed species in a particular region.
GHG emissions	Computed regionally using IPCC guidelines, and globally using estimated emission intensities per commodity and simulated trade flows.	Computed for individual farms by production activities using IPCC guidelines, and aggregated to the regional level.
Pesticide emissions	Not applicable.	Computed using average application rate per crop, year and ha, and standard active substance per application in kg.

Table 3.2 Computation of structural and economic indicators.

	CAPRI	AgriPoliS
Land use	Areas within NUTS2 regions.	Individual plots within selected regions.
Land productivity	Regional yields and input use respond to economic incentives.	Individual plots identified based on spatial location and biophysical characteristics.
Land abandonment	Captured as the difference in land use between scenarios.	Explicit choice of the farmer at the field/plot level.
Production	Available on NUTS2 level in Europe and for broad regions globally. Includes selected secondary outputs.	For individual farms in selected regions.
Farm structure	Not applicable.	Change in number and average size of farms in selected regions.
Farm income	Gross value added at producer prices plus premiums, on regional level.	Income per farm, also considering opportunity costs of own capital and labour.
Producer prices	Endogenous variable of the model.	Exogenous (taken from CAPRI).
Consumer prices	Endogenous variable of the model, with fixed mark-up from producer prices.	Not applicable.
Consumer welfare	Money metric, i.e. a monetary measure of consumers' utility function.	Not applicable.
Tax payer effects	Impact of entire CAP, but no info on spending outside of CAP.	Not applicable.

3.4 The CAPRI model

CAPRI (Britz and Witzke, 2014) is a model of the agricultural sector covering the entire EU and some auxiliary European countries.[9] It is a partial equilibrium model which means that it only considers effects in the agricultural sector while ignoring potential interactions with other sectors. All simulations with CAPRI are *comparative static*. This means that effects on land use, prices, incomes, nutrient leakage, etc. are elicited by comparing the outcome in the optimum with one policy to that in the optimum with another policy, but the dynamics leading to the new optimum are not analysed. To this end, a *baseline scenario* is computed in the model, based on the Agricultural Outlook published by the European Commission (European Commission, 2016c). The baseline scenario is calibrated, meaning that parameters describing the reactions in the sector are adjusted to make the model behave in accordance with the data. In the simulation scenarios, the policy changes are introduced, while all other conditions are left unchanged, and the changes in relation to the baseline are computed for a future point in time.

CAPRI consists of two modules that interact, as illustrated in Figure 3.2: a supply module for Europe and a global market module where trade and prices are computed. The supply module comprises one representative farm model for each NUTS2 region[10] in the EU and corresponding administrative units in the auxiliary countries. There are presently 276 such regions in the module. All representative farm models have the same mathematical structure but are based on data for the specific region. They optimise regional agricultural income, given prices of inputs and outputs, and levels of support. They are constrained by the availability of land, policy parameters, the balance of intermediate inputs such as young animals, manure and fodder, and feed and plant nutrient requirements in each region. The optimisation also considers regionally specific behavioural parameters that govern how costs change if production changes, and how the supply of agricultural land reacts to changing land rents.

[9] EU-28 plus Turkey, Norway and the Balkan countries.
[10] See Eurostat web page on for a definition.

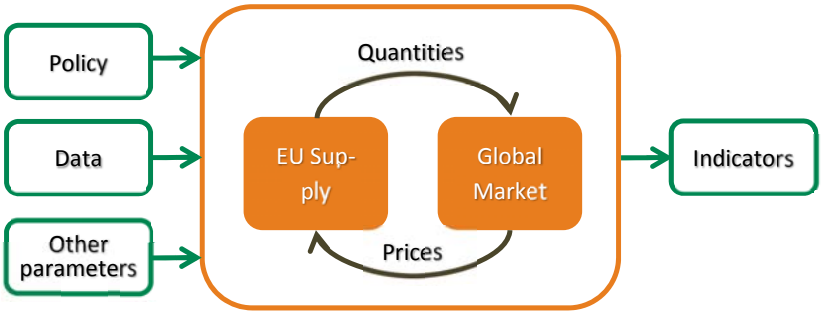


Figure 3.2 Structure of the CAPRI model.

The supply module covers 55 agricultural inputs and outputs, produced or used in 61 activities. Agricultural activity is modelled with inputs to crop and livestock production from other sectors as well as intermediate inputs such as feed and young animals produced by farms. The supply module has a detailed representation of the various policy instruments for each region, especially those in Pillar I, making it suitable for analysing the impacts of agricultural policies. Most production activities in CAPRI are available as two technological alternatives, representing "high yield, high input" and "low yield, low input", that together represent the average technology but allow for intensification or extensification in simulations in response to changing conditions.

CAPRI does not explicitly model the use of capital and labour. Therefore, the model does not compute impacts on farm structure. Other research groups have derived employment indicators based on the model results using coefficients for labour requirements. However, as employment impacts are beyond the scope of this study they are not analysed.

In the supply module, farmers are assumed to be price-takers, i.e. taking prices that are fixed from the perspective of the individual farmer. Nevertheless, all farms collectively influence EU and world market prices through a global market module where prices, demand and trade are

modelled. The supply module and global market module are linked.[11] CAPRI runs until it reaches an equilibrium where prices are such that all markets for final products, processing, young animals and tradable feed are cleared. Consumers, producers and traders in the market module are represented by economic agents that follow traditional micro-economic theory regarding behaviour, thus enabling the computation of *welfare effects*.

CAPRI can be used to compute several environmental indicators. The supply module contains nutrient balances, where uptake by crop growth has to be matched by nutrient deliveries from several possible sources: mineral fertiliser, manure, crop residues (for nitrogen (N), phosphorus (P) and potassium (K)) and atmospheric deposition and fixation (for N). Uptake follows a crop growth function, and the availability of nutrients differs by source, contributing to over-fertilisation and losses depending on nutrient sources, crop choice and yields. This information is used to compute indicators for nutrient surpluses. Technical information in the supply module is also used to compute indicators for greenhouse gas (GHG) emissions, based on IPCC methodology. The emission computations in the supply module are complemented with estimated emission intensities for globally traded commodities, allowing us to model changes in global GHG-emissions resulting from changing global trade and production patterns.

More information about the CAPRI model, including technical documentation, lists of peer-reviewed and other publications, and open access to the modelling system, is available at the model webpage: www.capri-model.org.

3.5 The AgriPoliS model

AgriPoliS is an agent-based model comprising a population of heterogeneous farm-agents that are competing for agricultural land in a defined region (Balmann, 1997; Happe et al., 2006). The strengths of AgriPoliS

[11] The market model contains an approximation for the supply models. After solving the supply model at fixed prices, the approximate supply functions in the market models are re-calibrated to reproduce the behaviour of the supply models. Then the entire market is solved for new equilibrium prices that are used in the subsequent solution of the supply models.

are that it models farmer behaviour from the bottom up (*i.e.,* individually optimising farms), represents the spatial distribution of farms and fields in the region, and captures competitive interactions among farms via an endogenous land market. Furthermore, it models the strategic decisions whether to invest in new capacity and continue farming, or close down and release land to the land market (Figure 3.3). A change in the political environment (a policy scenario) sets off a dynamic process of structural adjustment, which we analyse with AgriPoliS.

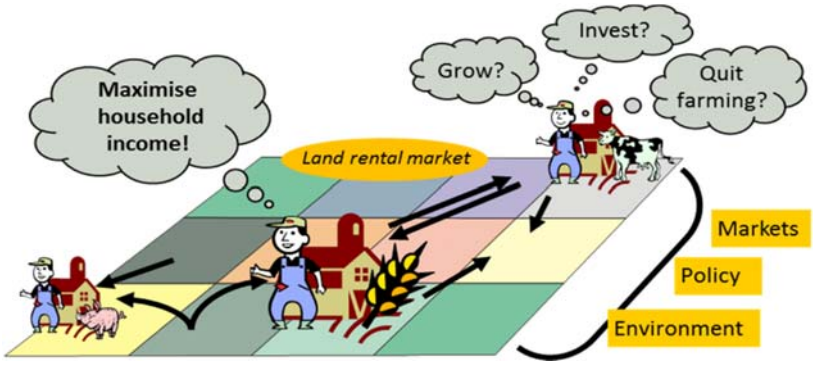


Figure 3.3 AgriPoliS farmers act to maximise their income within an economic, technological, political and spatial context, which influences the process of structural development.

A region in AgriPoliS is based on a selection of typical farms from data on real farms (i.e. Farm Accountancy Data Network) that are scaled up to represent the entire population of farms in the region (Sahrbacher and Happe, 2008). By typical farms we mean farms that are representative of the diversity of farms typically found in the region. These typical farms differ in terms of size and production activities; specialised crop and livestock farms or mixed farms, large and small farms, etc. Through a mathematical optimisation framework, farmers in AgriPoliS strive to maximise the family's income by optimising their decisions about what and how much to produce, which investments to make, whether to use available family labour and capital on or off the farm, whether to rent more land or release land, and whether to continue farming at all. The location of fields, field size, soil quality and ownership are also consid-

ered in the form of a two dimensional spatial grid, which together with the modelled production activities define the landscape in which farms are embedded (Brady et al., 2012). This spatiality means that differences in transportation costs to fields from farm centres and scale-economies of field operations, as well as differences in soil quality are considered. Consequently, AgriPoliS makes policy analysis possible at a micro and spatially explicit level, which is important for studying structural change and environmental impacts over time. Technical details of the model can be found in Kellermann et al. (2008) and a broader overview in Sahrbacher et al. (2012).

Due to their heterogeneity in terms of particularly resource endowments and a farm's biophysical characteristics, farmers can respond differently to the same shocks, such as a policy change. For example, highly fertile regions on the plains are likely to display the strongest reactions to stricter pesticide regulations, because they tend to be dominated by specialised crop farms that use pesticides more intensively than farms with livestock production. Similarly, two livestock farms in the same region may react differently to an increase in the price of beef, because one farm is able to rent additional pasture while the other is located too far from available land to make expansion profitable. This heterogeneity among farms, between and within regions, is an important feature of AgriPoliS, making it possible to analyse the potential impacts of a policy at a more detailed level, i.e. differentiate impacts among individual farms according to their characteristics.

Results generated by AgriPoliS at both the farm and regional levels include: areas and yields of crops, types and numbers of livestock, developments in farm specialisation and size, profits from agriculture and off-farm income, labour hours, input usage (fertilisers, chemicals and energy), land rental prices, investments and full accounting data for individual farms. Environmental results include changes in land-use, biodiversity, nutrient balances, pesticide usage and GHG emissions.

3.6 AgriPoliS regions – an uneven playing field

As explained above, AgriPoliS covers only selected regions. Swedish agriculture faces very heterogeneous conditions: from wide and fertile plains to water-rich hilly areas of coniferous forests, boreal taiga and subarctic climate. The results of our analysis are very much explained by these differences; hence we devote this section to a description of the four Swedish study regions, as well as some of the environmental considerations pertaining to each of them.

We model two regions that are marginal in terms of their agricultural productivity, the subarctic and the mixed-forestry regions, one relatively productive region, the mixed-farming region and one, by EU standards, highly productive region; the intensive-cropping region. Table 3.3 provides some descriptive statistics, Figure 3.4 places the regions on a map and Figure 3.5 summarises environmental issues associated with agriculture and their relevance in the respective regions.

Subarctic – The subarctic region is modelled using the northern region of Västerbotten, a marginal agricultural region with only one per cent being agricultural land that is concentrated along river valleys (Table 3.3), located just below the polar circle. It is endowed with good quality soil, but crop yields are moderated by a very short vegetation period and natural barriers limiting expansion of farms. All agricultural land in the region is therefore classed as marginal. Consequently, farms are small, 29 hectares on average, and the feasibility of exploiting scale economies is small, resulting in relatively low returns per hectare. The main activity is livestock production, predominantly milk and beef, and agricultural land is dominated by temporary grasses for feed. Due to its status as an Area of Natural Constraints (ANC), the subarctic receives additional payments under Pillar II, as well as substantial payments under the Nordic Aid scheme (Box 3.4).

Due to the scarcity of agricultural land in the subarctic region and the presence of traditional semi-natural pasture for grazing livestock, agriculture is important for preserving biodiversity in the region (Figure

3.5).[12] On the other hand, livestock farming gives rise to GHG emissions contributing to climate change, and ammonia and nitrous oxide emissions causing air pollution. Pesticide use is though relatively low thanks to the climate.

Table 3.3 Agricultural characteristics in the four study regions.

	Subarctic	*Mixed-forestry*	*Mixed-farming*	*Intensive-cropping*
Regional land use				
agriculture	1%	12%	39%	57%
forest*	73%	71%	38%	15%
other	26%	17%	24%	28%
Area managed by farms				
agriculture	24%	39%	71%	85%
forest	76%	61%	29%	15%
Agricultural land				
arable	97 %	69 %	75 %	95 %
semi-nat. pasture	3 %	31 %	25 %	5 %
Main production	Livestock	Livestock	Mixed	Crops
Average farm size (ha)	29	37	64	71
Land on farms <50 ha	36 %	44 %	22 %	15 %

*Note: Most statistics pertain to the year 2013. Source: (Statistics Sweden, 2014); (Swedish Board of Agriculture, 2017). * Forest areas in the mixed-farming and intensive-cropping regions are approximated.*

[12] Semi-natural pasture is permanent pasture on agricultural land that is unsuitable for ploughing. It is not heavily fertilised or reseeded and hosts a composition of organisms similar to that in a natural habitat. It is thereby more valuable for delivering public goods, such as biodiversity and cultural landscape, compared to intensively managed pasture on arable land.

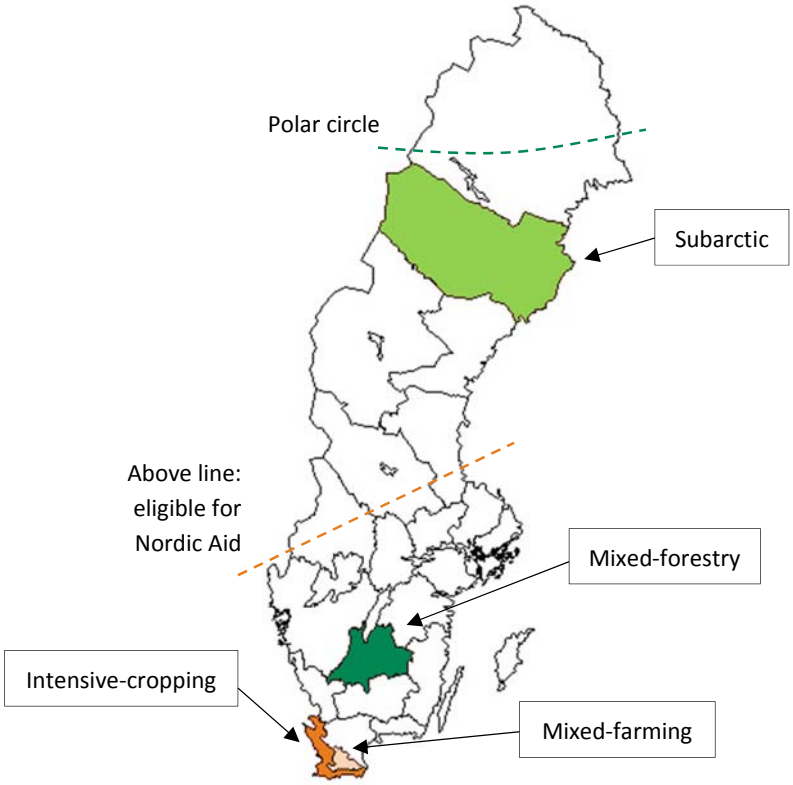


Figure 3.4 Four agricultural regions of Sweden are modelled in AgriPoliS: sub-arctic (Västerbotten County), mixed-forestry (Jönköping County), mixed-farming (central Götaland) and intensive-cropping (plains of Götaland).

Mixed-forestry – Our second marginal region, mixed-forestry, is characterised by a mix of livestock farming and forestry. We use the county of Jönköping as our case for the mixed-forestry region, an area of about 1 million hectares where the landscape is characterised by hills, lakes and forests interspersed with fragments of agricultural land. Of the total land area, 12 per cent is agricultural land and 71 per cent is forest, and due to the fragmentation of agricultural land the average farm is 37 hectares.

Productivity in the region is low due to the sandy soil that is littered by rocks and boulders, and, as a consequence, yields are relatively low and all agricultural land is considered marginal. Milk and beef are the foremost enterprises, with a large share of feed requirements based on grass (silage and pasture). Due to the unfavourable agricultural conditions, farmers in the region receive some compensatory ANC payments, but do not receive Nordic Aid support despite comparably poor production conditions to the subarctic due to the inland climate, as they are too far south.

The large area of semi-natural pasture in the mixed-forestry region, which is dependent on grazing by ruminants, is crucial for conservation of biodiversity by providing habitats for organisms, as islands within the large coniferous forests, and preservation of the cultural landscape. Simultaneously, livestock production is damaging to water quality and to the climate by emitting nutrients and greenhouse gases.

Mixed-farming – The central districts of Götaland are used to model our mixed-farming region. It is part of the continental zone and has good soil quality, but is an undulating landscape interspersed with forest, creating a somewhat fragmented agricultural landscape; 39 per cent of the area is agricultural land of which 49 per cent is considered marginal. Farms are on average 64 hectares; larger than in the subarctic and mixed-forestry regions, but smaller than in the intensive-cropping region. Production is mixed with both specialised crop and livestock farms. The farm structure creates an elaborate mosaic of land use in the landscape, which is positive for biodiversity. The region has large variation in farming activities, which makes a wider range of possibilities available for adapting to change, compared to a specialised region.

Owing to the large variation in activities, the environmental concerns linked to agriculture are both GHG and ammonia emissions from livestock and pollution of water from crop production. Extensive farming activities and the large share of semi-natural pasture in the region are at the same time important for conservation of endangered species and the cultural landscape.

Intensive-cropping – In the southernmost county of Scania we find Götaland's plains, which is our case for the intensive-cropping region. The climate is mild, the soil highly fertile, and yields are the highest in the country. As shown in Table 3.3, over half of the total area in the region is agricultural land, and nearly all of the agricultural land is high-productive arable land. High value crop production dominates, mainly cereal crops, oilseed rape and sugar beets. Since there are few natural barriers in the landscape farms can grow without invoking large logistic costs, only limited by the availability of land on the market. Farms are therefore larger than the national average at 71 hectares, and economies of scale combined with the high yield levels result in relatively high hectare returns.

Because of the high share of crop farms and the intensity in farming methods, negative impacts on the environment are prevalent in the region. Biological degradation of soils affects carbon storage and nutrient retention negatively as well as other ecosystem services, and nonpoint-source pollution from application of fertilisers and chemicals are serious problems (HELCOM, 2010; Tsiafouli et al., 2014). Furthermore, high application rates of pesticides and fertilisers, absence of grass in crop rotations and homogenisation of the agricultural landscape, all of which are features of farming in the intensive-cropping region, are damaging to biodiversity.

In Figure 3.5, an overview of environmental problems associated with agriculture in the EU is given and the relevance of the problems to the Swedish case study regions is indicated.

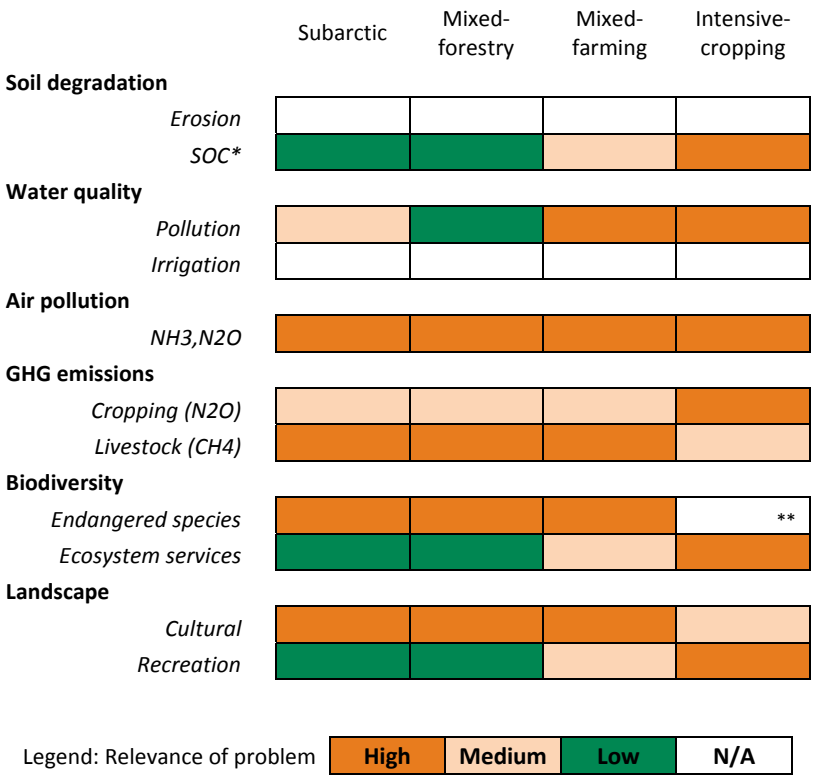


Figure 3.5 Overview of environmental problems associated with agriculture in the EU and relevance to the Swedish case study regions.

** Soil Organic Carbon (SOC) is a measure of the flow of ecosystem services the soil contributes with, and thus an indicator of soil quality.*

*** There are no endangered species that are dependent on farmland for survival in the intensive-cropping region. Preservation of endangered species is thus not an argument for maintaining farmland in the region.*

The results from the Swedish case-study are of interest also in a broader European context by indicating how comparable regions are affected. Parallels between regions are pointed in Box 3.3.

Box 3.3 Application of the Swedish case-study results to other Member States

Data on farming systems, input intensity, share of high nature value (HNV) farmland and LFA classifications for NUTS 2 regions suggest the following:

- The characteristics of the Swedish *subarctic region* bears similarities to some European regions in its low input-intensity methods, LFA status and livestock domination, but is different from most by being subject to climate conditions that are comparable only with northern Finland.
- The *mixed-forestry region* is an LFA-classified area dominated by low-intensity dairy and beef farming and with a high share of HNV farmland. This is also true for central and south-eastern France, and south-eastern Germany.
- The characteristics of the *mixed-farming region*, where farming activity is mixed, input-intensity medium and some areas classified as HNV and LFA, bears similarities to north-eastern Germany, western France, the Danish peninsula and northern Austria.
- The *intensive-cropping region* is similar to areas in north-central France, south-eastern England, and the Danish isles, in that farming is dominated by high-intensity cropping, with no or little HNV farmland and no LFA status.

The effects identified for the Swedish regions can, naturally, not be expected to match other regions perfectly, because of the great complexity in farming systems, landscape characteristics, climate, national political systems, and more, across Member States. For more detailed regional results in other parts of the EU, a more rigorous analysis taking local characteristics into account is needed.

Finally, the share of CAP elements that are under member state discretion has grown since the 2013 reform. In Box 3.4 a brief overview of specific features of relevance for our case-study in Sweden is provided.

Box 3.4 Brief overview of CAP in Sweden 2015-2020

The basic payment scheme

In 2015 a process of harmonising the Swedish basic payment scheme was initiated; from 2020 and onwards all Swedish farmers will receive a flat €193 per hectare and entitlement throughout the country, irrespective of historical support levels.

Greening Payment

To receive Greening Payment, Swedish farmers must comply with the three greening conditions. In practice only the third condition (EFA) requires Swedish farmers to act, because the first two conditions were effectively already fulfilled on the introduction of the Greening Payment. Furthermore, the EFA obligation applies only to farmers in mixed-farming and intensive-cropping regions because of an exemption from the obligation for farmers in mixed-forestry and subarctic regions. These latter regions are deemed to already provide sufficient environmental benefits, and receive Greening Payment whether they fulfil the greening conditions or not.

Coupled cattle payment

In 2015 Sweden introduced Voluntary Coupled Support (VCS) for cattle producers. The annual payment amounts to €91 per animal older than one year and in total represents 13 per cent of the direct payments budget (the maximum allowed by the EU).

Pillar II support and the Nordic Aid scheme

Two other features of the Swedish implementation of CAP are important; the compensatory support under the European areas of natural constraints (ANC) regulation in Pillar II and the Nordic Aid scheme. The ANC support targets areas with natural or other specific constraints, i.e. areas where farmers face higher costs of production than an EU benchmark due to geography, topography or climate. In Sweden this applies to farmers in subarctic and mixed-forestry regions. Second, Swedish (and Finnish) farmers in certain areas, notably the subarctic, are eligible for Nordic Aid, which provides production support to specific enterprises, primarily dairying in Sweden, and compensatory support for long distances and adverse climate conditions. The Nordic Aid scheme is entirely financed by Sweden.

3.7 Differences and complementarities between the models

Our two simulation models CAPRI and AgriPoliS are both mathematical programming models where farms maximise income. At the same time they differ in important ways. The comparison made in the following section is summarised in Table 3.4.

Table 3.4 Comparison of the CAPRI and AgriPoliS models.

	CAPRI	AgriPoliS
Spatial resolution of agricultural *production*	All NUTS2 regions.	Individual farms and fields.
Agricultural *markets*	Global.	Regional.
Land use	Aggregated at regional level. No spatial considerations within NUTS2 regions.	Individual plots are modelled, each of which has specific potential yield and ownership. Distances between fields and farms influence costs.
Labour	Modelled indirectly in cost functions.	Explicitly modelled.
Capital	Modelled indirectly in cost functions.	Explicitly modelled.
Costs and simulation behaviour	A residual, non-linear (increasing in activity) cost term is used to steer the reaction to changed incentives.	All costs are explicitly modelled. Costs can be reduced by investing in larger capacities or renting more land.
Temporal resolution	Static simulation of a single future point in time.	Dynamic simulation of each year up to a target year.
Agricultural policy	Pillar I and II instruments directed to agriculture captured. Difficult to model farm-level measures or spatial measures such as buffer strips. Market policies included.	Pillar I and II instruments captured. Possibility to model farm level or spatial specifics of policies. Not possible to model market policies.

In contrast to AgriPoliS, there are no explicit spatial considerations in CAPRI, rather, arable land and grassland within each NUTS2 region are

considered homogeneous.[13] Further, since all agriculture is aggregated to one representative farm for each region, differences among farms *within* regions are averaged out and not visible in simulations. The main advantage of this approach is the broad coverage of all agricultural production in the EU, enabling a consistent budget and closed markets for intermediate products such as fodder and young animals, and the link with demand and world trade. On the other hand AgriPoliS is a model of agricultural dynamics where decisions at the farm level and their emergent impacts at the regional level are in focus. AgriPoliS is based on actual individual farms in selected areas of Sweden (for this study), where heterogeneous characteristics of farms and the spatial characteristics of land influence structural development and changes in the use of agricultural land. By taking heterogeneity within regions into account, AgriPoliS provides insights into the implications of various local and regional characteristics for structural change, which can be extrapolated to other European regions with similar characteristics (see Box 3.3).

AgriPoliS is a recursive dynamic model, that is, optimisation decisions are taken stepwise and over time in response to changing circumstances and other farmers' actions, which allows for a more complex adjustment process. In CAPRI, only the changes in the equilibrium quantities and prices are modelled, not the adjustment path. In theory, the results in the final year could be identical in the two models. However, the recursive dynamic structure of AgriPoliS allows for making sluggish developments, such as investment decisions and depreciation, explicit, whereas in CAPRI, sluggishness needs to be captured indirectly by adjusting (other) cost parameters.

Because AgriPoliS' results are based on individual farmers' optimisation decisions, a greater level of detail in revenues and costs is available. Such detail is not necessary in CAPRI, where some variables are modelled indirectly or in a residual term. For instance, the spatial dimension in AgriPoliS means that distances to fields and within-region variation in land quality are taken into account, together with their associated costs.

[13] Changing land use implies changing costs, but this mechanism is *not* further decomposed into components such as heterogeneity of land, spatial patterns, labour and capital constraints, risk etc.

Hence natural conditions influence farmers' production decisions in AgriPoliS, which is of particular importance when analysing regions where agricultural land is highly fragmented, such as in the marginal regions of Sweden, and for evaluating impacts on public goods such as preservation of biodiversity and cultural landscapes, which are heavily influenced by spatial factors.

In CAPRI, only the aggregate impact on the representative farm is modelled, not the spatial diversity within regions. Heterogeneity of resources such as land, management skills, etc. are instead captured by non-linear parameters. The non-linearities allow for changing marginal effects. For example, the cost of producing another tonne of cereal can increase with the total acreage, as fields of lower and lower productivity are taken into production. In contrast, AgriPoliS models production costs as depending on the productivity of the particular field that is farmed, which can change if the farmer makes investments to exploit scale economies, but that is otherwise given. The non-linear terms give a smooth response of CAPRI to exogenous shocks, whereas AgriPoliS responds in a series of small jumps as the farmers make decisions about how to use each field, rent or let land, or make investments.

The different modelling approaches in CAPRI and AgriPoliS give somewhat different results regarding the extent of land use changes in simulations. CAPRI appears to give more conservative effects of large reductions in subsidy levels than AgriPoliS. However, since the models work at different scales – even the CAPRI-region of "Southern Sweden" contains two entire AgriPoliS regions and more – a direct comparison is difficult. Instead the model results should be considered in relation to the specific questions of enquiry: what is likely to happen at the large scale (CAPRI) or what could the local effects of a particular policy be (AgriPoliS).

AgriPoliS provides great insight into the structure of selected regions. The downside is that it does not tell us anything about effects on markets and prices. This is because relatively small regional changes rarely have any effect on output prices, which are given by the world market and

hence not determined within the model. European agriculture on the other hand can affect prices and this is captured in CAPRI, which contains a price feedback from global markets. The price effects identified in CAPRI are though transferred to AgriPoliS, which improves the accuracy of AgriPoliS.

Because of the differences described above, we are likely to see some differences in simulation results when we combine the two models in one analysis, primarily the strength but not the direction of an impact. However, part of the benefit of using both models also lies within their differences, since we are provided with alternative perspectives; large and fine scales.

4 Results of the CAPRI simulations

In this chapter we use the CAPRI-model to investigate how direct payments and the two alternative instruments impact agricultural land use, production, incomes, nutrient surpluses, and greenhouse gas (GHG) emissions. The baseline scenario (REF) implies a continuation of the current policy. To investigate the impact of the Pillar I direct payments we compute an alternative scenario (NO DIRECT PAYMENTS) where direct payments and conditions are not present, and compare the results to REF. We then proceed to analyse the effects of two alternative policy instruments, i.e. i) a payment for marginal land (PUBLIC GOODS) and ii) a tax on mineral fertilisers to control nutrient leaching (TAX).

The main results are presented for the EU as a whole. As described in the previous chapter, the different scenarios are compared to the reference scenario (REF), at the same point in time – 2025. To analyse the impacts in more detail, six contrasting Member States are given special attention; Spain (ES), the Netherlands (NL), Germany (DE), Sweden (SE), Poland (PL) and Bulgaria (BG). These Member States were selected because they to some extent cover the variation in EU agriculture, spanning the union geographically from north to south and east to west, and include "old" as well as Member States that have joined more recently. We begin the chapter by summarising the findings. Simulation results for important indicators are given in Table 4.1.

4.1 Summary of results

Results of the NO DIRECT PAYMENTS scenario indicate that the direct payments contribute to preserving agricultural land use. Without them, agricultural land use in the EU is 6.5 per cent lower, compared to the REF scenario. This impact at the EU level conceals large regional varia-

tions at the NUTS2 level, which are analysed in more detail in chapter 5. The impact on agricultural output is proportionately smaller than the impact on land use, because without the payments, intensity and hence yields are higher.

The simulations show that GHG emissions and nutrient surpluses are higher with the direct payments than without them. In other words, the direct payments contribute to pollution rather than alleviating it. Without them, GHG emissions would be 2.5 per cent lower, and nitrogen and phosphorus surpluses 2.4 per cent and 2.3 per cent lower, respectively. However, less agricultural land use also implies a potential loss of valuable types of agricultural lands that could be contributing to provisioning of public goods (analysed in chapter 5). The payments boost agricultural income by almost €36 billion (21 per cent) in the EU as a whole, whereas taxpayers spend almost €41 billion more in the REF scenario than in the scenario without direct payments.

The PUBLIC GOODS scenario indicates that land use could be maintained at a level similar to that achieved with direct payments (REF), without an associated impact on production. The results of the PUBLIC GOODS scenario show a small decrease in land use, about 1.7 per cent relative to the REF scenario, but production is about as high as in the NO DIRECT PAYMENTS scenario. GHG emissions and nutrient surpluses are though lower than in both the scenarios *with* and *without* direct payments. As in the NO DIRECT PAYMENTS scenario, agricultural income falls and taxpayers save, albeit to a lesser extent; the payment for marginal land transfers however less money from tax payers to farmers than the current system.

In the TAX scenario, nitrogen and phosphorus surpluses are lower than in the REF scenario, by 4.8 per cent and 5.3 per cent respectively. In fact, the surpluses are even lower than in the NO DIRECT PAYMENTS scenario, indicating that a tax on nutrients is indeed more effective than the present Pillar I when it comes to reducing nutrient leaching. The impact is explained by smaller agricultural land use and production as well as a lower nutrient surplus per hectare. Agricultural income decreases and

taxpayers save money in the TAX scenario compared with the NO DIRECT PAYMENTS scenario. The reader that compares the impacts on nutrient surplus in TAX to that in PUBLIC GOODS may note that the latter is larger, which may seem odd. The reasons are explained in section 4.4.

Table 4.1 Summary of results from the EU-level analysis; relative changes in key indicators compared to REF-scenario with direct payments.

	NO DIRECT PAYMENTS	*PUBLIC GOODS*	*TAX*
Land use	-6.5%	-1.7%	-7.3%
Production			
Arable land	-3.9%	-0.8%	-4.9%
Pasture	-11.6%	-3.4%	-12%
Beef cattle	-4.8%	-5%	-4.9%
Dairy	-1.4%	-1.5%	-1.4%
Pigs	-0.2%	-0.3%	-0.4%
Poultry	-0.3%	-0.3%	-0.6%
Other animals	-2.7%	-2.8%	-2.8%
Agricultural income	- €36 bn	- €11.6 bn	- €39 bn
Taxpayer savings	€41 bn	€15 bn	€45 bn
Consumer surplus	- €3 bn	- €3.5 bn	- €5 bn
GHG emissions	-2.5%	-2.9%	-3.6%
Nutrient surplus			
Nitrogen	-2.4%	-5.2%	-4.8%
Phosphorus	-2.3%	-7.1%	-5.3%

In the rest of this chapter the results are analysed in greater detail. The analysis is done scenario by scenario. All outcomes are compared with the REF scenario (with direct payments), but also with the NO DIRECT PAYMENTS scenario, in order to investigate the impact of the alternative policies. Key simulation results are summarised in Table 4.1.

4.2 NO DIRECT PAYMENTS scenario – analysing the impacts of the current Pillar I direct payments

We begin by looking at the results for the NO DIRECT PAYMENTS scenario where direct payments in Pillar I are not present (for a description of the scenario, see Box 3.1). Understanding the impacts of support and changes in support levels is helpful for understanding the impact of policy changes on interesting variables, such as land use, production, and associated GHG and nutrient emissions. We therefore begin with a brief description of changes in support levels in the NO DIRECT PAYMENTS scenario. An account of the current CAP is given in chapter 2.

Changes in agricultural support

To obtain an indication of the relative importance of Pillar I direct payments for farmers we look at how large a share these are of total revenues – which we define as sales revenues plus agricultural support.[14] Pillar I direct payments as a share of total revenues is, on average in the EU, seven per cent. In Figure 4.1 this is shown by the green section of the lowest bar. Although the CAP is a common EU policy, there are differences between regions as well as sectors. This depends on the profitability in production as well as the fact that Member States have different support levels and divisions of funds between Pillar I and Pillar II. For example, the share of Pillar I direct payments in total revenues ranges from 2.1 per cent for the Netherlands to 12.3 per cent for Bulgaria. Of course regional variations within countries will be larger. The share of direct payments in total revenues indicates how economically dependent the production in the region in question is on them.

[14] Only income from primary agricultural production is accounted for. Other household income or income from diversification such as local processing or machinery services is not included in CAPRI. Neither should the share of support in revenues be confused with the support's share of *total factor income*, which is often referred to otherwise (where costs are subtracted).

Without the Pillar I direct payments total support would be 80 per cent lower in the EU28 (according to CAPRI[15]). The remaining support (the light orange parts of the bars) differs more among regions and sectors because it is regionalised, such as: Pillar II Areas with Natural Constraints (ANC) support, targeted environmental schemes, and various payments from the Member States systems, such as the Nordic Aid Scheme in Sweden or support to e.g. beef cattle and agricultural land in Bulgaria. The relative decrease in total support is similar in most Member States, although in some countries, like Sweden, the change is smaller (64 per cent). These differences are explained by Sweden having a large share of Pillar II payments and, for some other Member States, by larger shares of national payments. In contrast, in Spain, without direct payments total support is 90 per cent lower and in the Netherlands 94 per cent lower.

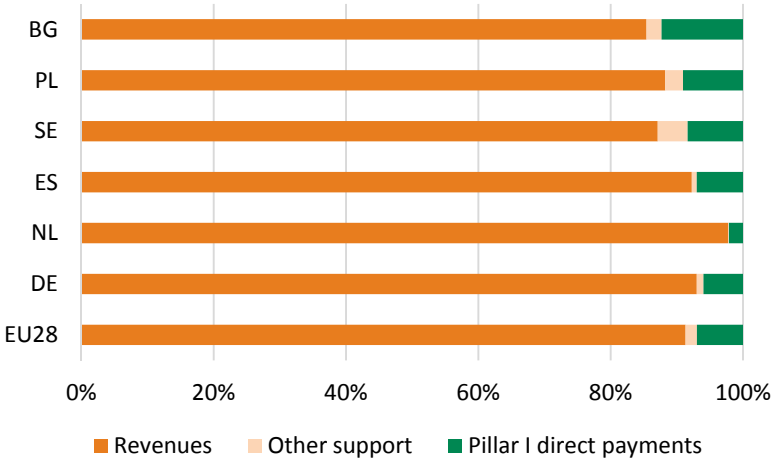


Figure 4.1 Sales revenues and agricultural support as share of total agricultural revenues in the REF scenario, in 2025.

[15] In CAPRI, only support going to agricultural production is considered, as only this should affect agriculture. Support such as LEADER for rural development is not included, and neither is the support to investment. As these non-included support are in Pillar II, the decrease would have been smaller if they were included, about 70 per cent which is the number you often see as the share of Pillar I in CAP.

The differences in the Pillar I direct payments as a share of total revenues depend on factors such as the types of support, if production is land intensive, and on the profitability of production. For instance, sectors receiving Voluntary Coupled Support (VCS) have support in addition to the Basic Payment Scheme (BPS), and as this contributes to the total revenues it can make particular sectors more dependent on Pillar I direct payments. Since the Basic Payment Scheme is more or less equal per hectare[16] for all sectors in a region, it constitutes a large share of total revenues in sectors with low sales revenues per hectare. In the EU, pasture is highly dependent on Pillar I direct payments (28 per cent of the total revenues from such lands), while pig production is hardly dependent on Pillar I direct payments (less than one per cent of total revenues). Thus, a Member States with a large share of sectors for which a large part of total revenues is made up of Pillar I direct payments is typically more dependent on the current policy and hence react more strongly to our NO DIRECT PAYMENTS scenario.

Moreover, different types of support affect agriculture in different ways. For instance, the largest support, the Basic Payment Scheme, is decoupled from production as all managed land (with entitlements) is eligible even without commodity production. For many regions there is also coupled support tied to specific production activities; Voluntary Coupled Support to e.g. cattle in many Member States, as well as national support in some Member States coupled to a specific type of production. Coupled support gives an incentive to maintain (or increase) production of the specific supported activity. Direct payments however can affect production in some areas via the associated land management obligations, where it is not economically optimal for the farmers to use the land without payments. Accordingly, the current support structure, as well as the competitiveness of agriculture in different regions, will determine how much it is affected by direct payments or an alternative policy.

[16] Through the convergence process the BPS will have been fully or almost fully equalised across farms in each Member State in 2025. The degree of convergence depends on the choice of the Member States.

Impacts on land use

The Pillar I direct payments contribute to increasing agricultural land use. Land use, prices and productivity are simultaneously affected, and understanding those interactions is important for understanding the effects on environmental and welfare indicators. Several factors have an impact on the size of the impact of direct payments on land use, of which the most important are; how important direct payments are for incomes, price effects, scarcity of entitlements, geographical differences, and the nature of production and how easily production can be changed. These factors interact in different ways in each region and are further explained below. While the model results summarise the impacts, we provide some examples of how the factors are functioning to illustrate different outcomes. Explanations covering all results are left out to focus on the broader picture.

In the NO DIRECT PAYMENTS scenario, the total agricultural land use decreases by 6.5 per cent in the EU, compared to the REF scenario. Arable land, constituting about two thirds of the agricultural area in EU, decreases by 3.9 per cent while pasture decreases even more, by 11.6 per cent. The changes in arable land and pasture uses are shown in Figure 4.2 and Figure 4.3, where orange indicates a decrease in a the respective land use, and green an increase. Results for the Member States differ substantially from each other and from those for the EU as a whole. The effects are even larger for the smaller NUTS2 regions.[17]

[17] Results available from the authors on request.

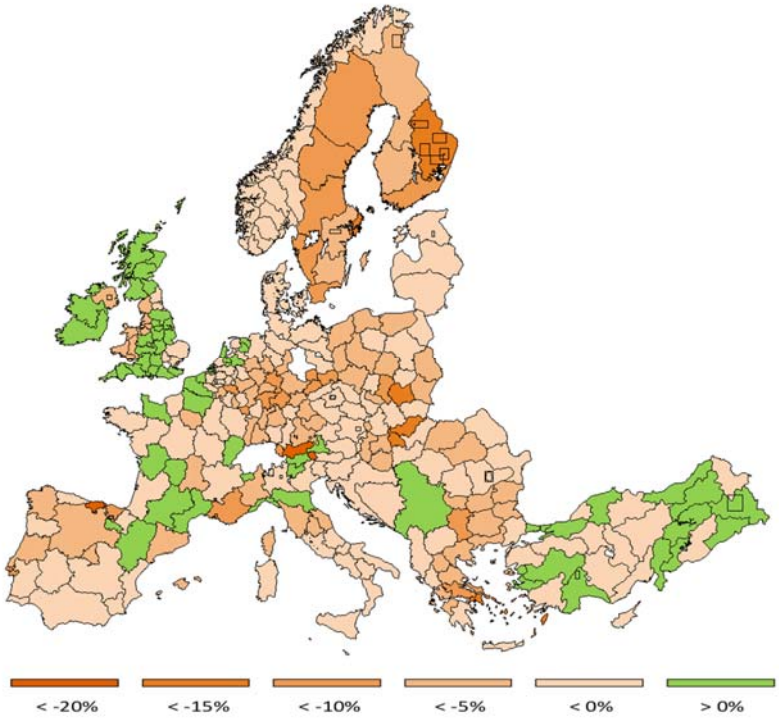


Figure 4.2 Change in arable land use in the NO DIRECT PAYMENTS scenario relative to the REF scenario, in 2025.

Note: the map indicates changes in each NUTS2 region. The agricultural area is not necessarily proportional to the area on the map, as agriculture is only one of many land uses in each region.

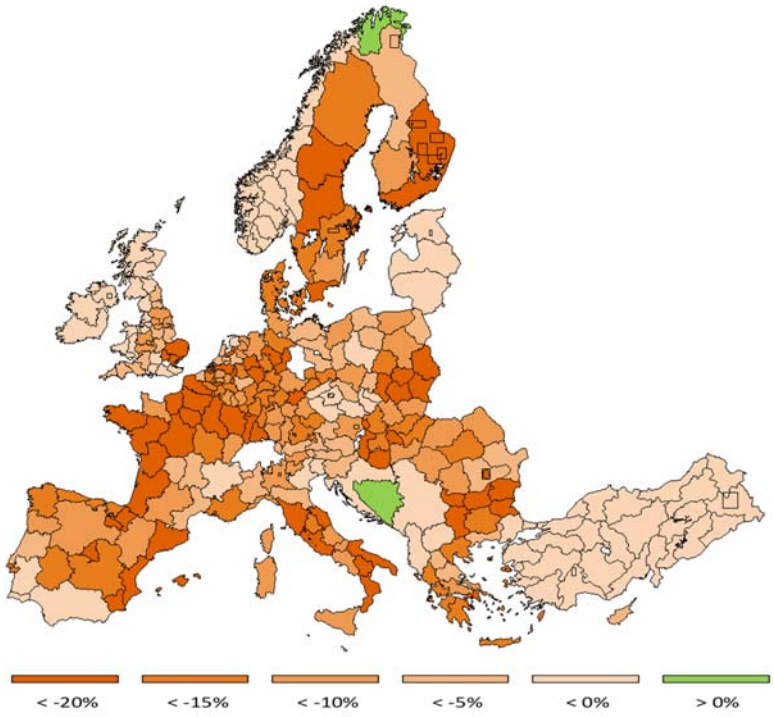


Figure 4.3 Change in pasture in the NO DIRECT PAYMENTS scenario relative to the REF scenario, in 2025.

Note: the map indicates changes in each NUTS2 region. The agricultural area is not necessarily proportional to the area on the map, as agriculture is only one of many land uses in each region.

The initial mechanism explaining the results and differences between regions and sectors, discussed earlier, is that the loss of support means that farming generates less revenues. As a consequence, the least productive and profitable land that does not cover the costs of farming activities, is abandoned (thus reflecting differences in agricultural conditions among regions).

For pasture, the differences in impacts are large, with changes ranging from zero impact to -55 per cent among the NUTS2 regions. For arable land most regions experience a reduction in land use comparable to that

of the EU average. However, some regions do in fact increase arable land use.[18] At the Member State level, the Netherlands increases arable land by 0.4 per cent, and there are NUTS2 regions with even larger increases. This is due to a net transformation of pasture to arable land use. This is explained by pasture, a more extensive land use, becoming relatively less profitable, if at all, without direct payments. The land used for pasture also changes more than arable land because pasture provides intermediate inputs (feed) for animals. Arable land, on the other hand, is to a larger extent producing commodities closer to the market for final consumption, with more stable demand and more intensive use of production factors such as machinery where the amounts employed are not easily adjusted.

For the Netherlands, support to arable land constitutes a small share of total revenues, which explains the limited effect of the policy change. In Spain, a large part of the agricultural area – relative to other Member States – is used for growing permanent crops such as olives and fruit. For these sectors production changes are slow due to the perennial plants with longer production cycles, and support is a relatively small part of total revenues. This contributes to the relatively small decrease in arable land which is only 2.7 per cent. At the same time, land used for pasture in Spain decreases substantially, by 14.2 per cent. In Bulgaria the average decrease in pasture is even larger, 22 per cent. There, in addition to a relatively high level of support in relation to sales revenues, cattle farms receive high Voluntary Coupled Support in the REF scenario, contributing to a large area of pasture.

Another reason for the differences in land use changes among Member States and regions is differences in geographical characteristics. Agricultural land can be changed into other land uses, and vice versa, and the cost of doing so differs among regions depending on geographical conditions. For instance, Sweden and Finland are two Member States where large parts of the agricultural area have low productivity due to climatic conditions. This results in lower land prices compared to, for instance, in the Netherlands, and gives incentives to convert them to other uses, for

[18] Results available from the authors on request.

instance forestry. This partly explains why there is a relatively large decrease in agricultural land use in these Member States.

Despite the incentives to reduce agricultural land use, the decrease in land use is dampened primarily in two ways in response to eliminating direct payments. Firstly, world market prices increase in response to changes in demand and supply when production decreases. This increases market revenues from the land, thereby making it more profitable to farm. The effect on the production of agricultural commodities is dampened, and land use change accordingly. This will be discussed further in a following section.

The second factor dampening the effect on land use is that the Basic Payment Scheme requires farmers to have a payment entitlement to receive Pillar I direct payments for each hectare of land, and only land with entitlements is included in the CAPRI model. For a Member State there can be more land available that could be managed profitably, than there is land with entitlements. In that case, the farmer would utilise her entitlements to obtain support for their most productive land and would put more land into use if they had more entitlements. Only when the support has fallen enough to make it unprofitable to maintain the least productive land in use, will further reduction of the support translate into a reduction of the agricultural land area in CAPRI. This mechanism absorbs some of the effect on land use – to various extents among the Member States depending on how scarce the entitlements are.

Impacts on production

Without the direct payments, not only land use would be lower, but also production of agricultural products. Production is linked to markets and affects prices. When the supply of agricultural products in such a large region as the EU decreases, producer prices rise compared with the REF scenario (by a few per cent), since demand is not affected to the same extent. Higher prices make production more profitable and as a consequence, both production and land use decrease less than if prices had not changed.

Crop production - The production mix on arable land would be different if there were no direct payments. Production of vegetables, fruits and other permanent crops like olives would not be much different since direct payments constitute a small share of total revenues in these sectors, and because their long production cycles make them react more slowly. Removing the payments causes fallow land to decrease more than other types of land use, as direct payments are the main source of income for fallow land in the REF scenario.[19] Sugar beet, soya and pulses are among the crops where production decreases the most without the direct payments, which is explained by the removed Voluntary Coupled Support constituting a large share of total but indirect revenues from these crops. As we shall see below, animal husbandry is not affected as much as crop production by direct payments, which indirectly changes the incentive to produce different types of feed, hence livestock numbers decrease moderately.

The results indicate that direct payments promote extensive production (lowering yields and input use). Conversely, removing the payments in NO DIRECT PAYMENTS results in an intensification of farming, both on arable land and on pasture. Output prices rise in relation to costs for inputs such as fertilisers. This makes it profitable to increase input use to raise productivity. Production is also redirected to more productive sectors and regions. Without direct payments, the least profitable fields no longer generate enough income and are abandoned. As a consequence, this also contributes to an increase in the average intensity. Higher productivity means that production does not generally decrease as much as land use. Taking Germany as an example, land for growing cereals declines by 6.5 per cent relative to the REF scenario. The decrease in quantities produced is, however, only 5.2 per cent.

Animal husbandry - The animal sector produces mainly meat, eggs and dairy products and uses agricultural land to generate inputs such as pasture and other feed. In many Member States, the NO DIRECT PAYMENTS scenario also involves removing Voluntary Coupled Sup-

[19] Fallow land can also be kept by farmers to use if they want to increase production in the future. This can make it rational to keep some fallow land even without a direct income.

port benefitting livestock production, mainly beef, dairy and veal, and these industries are thereby particularly affected. On the other hand, some Member States also have national support for animals which is not affected. Furthermore, animal husbandry is also affected by the changes in land use discussed in the previous section. In general, these impacts are not as large for animal production as they primarily affect animal producers through higher costs of one of the inputs; feed, and can change production mode to intensified production with another feed mix. Changes in herd sizes in the animal sector are shown in Figure 4.4.

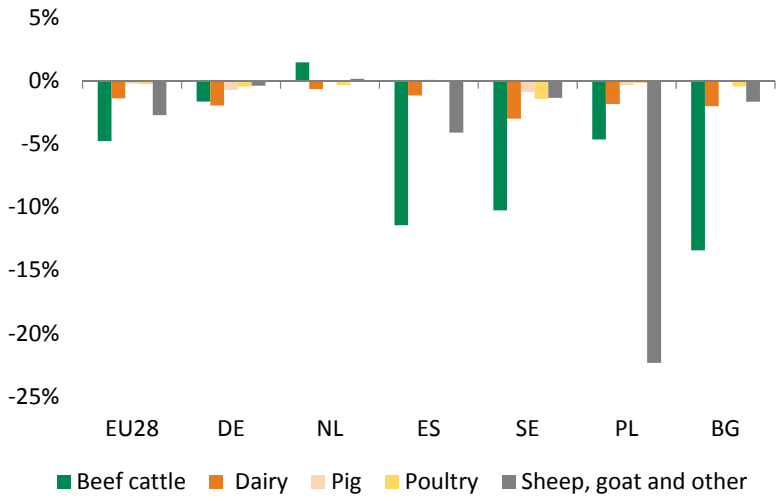


Figure 4.4 Animal numbers in the NO DIRECT PAYMENTS scenario relative to the REF scenario, in 2025.

The dairy sector is the largest animal sector in the EU. Here, herd sizes decline by 1.4 per cent without direct payments. Direct payments comprise a small share of total revenues in the dairy sector and the sector experiences small changes in the amount of support, which explains the small effects of the policy change. Additionally, some Member States, such as Sweden, have national and Pillar II support for dairy farms that are not changed. A further characteristic of the dairy sector is that it is capital intensive and as capital utilisation cannot be adjusted without de-

lay, responses to policy changes are slower than in less capital intensive sectors. In pig and poultry production, for which support is a very small share of total revenues, animal numbers decline by 0.2 per cent and 0.3 per cent respectively. In the NO DIRECT PAYMENTS scenario, the animal sector faces higher feed prices, which changes the feed mix and increases costs, thereby affecting production negatively. In fact, the main impact on pigs and poultry is caused by the higher feed prices.

Animals suited for grazing, such as cattle and sheep, are affected by the large reduction in pasture and fodder grass and the associated fodder cost increases. Beef cattle production decreases by 4.8 per cent relative to the REF scenario where also a large part of the explanation is the reliance on Voluntary Coupled Support. The Voluntary Coupled Support also contributes to the change in the dairy sector and in sheep and goat production. One Member State with Voluntary Coupled Support to cattle is Spain, where production of beef cattle decreases by 11.4 per cent. Germany, in contrast, has no Voluntary Coupled Support, and the effect of the policy change is consequently small; in Germany beef cattle decrease by 1.6 per cent without direct payments. For sheep and goats that also are grazing animals and receive Voluntary Coupled Support in some Member States, production declines by 2.7 per cent.

Impacts on the environment

Nutrient surplus - One of the most serious environmental problems associated with agriculture is nutrient leakage with e.g. eutrophication as a consequence. Nutrients, such as nitrogen and phosphorus, are applied to agricultural land to boost yields of crops and grasses. However, the applied nutrients often exceed the crops uptake, resulting in nutrient surpluses. The size of the surplus depends on the amount of nutrients added, which type of activity the land is used for and characteristics of the soil in the specific region. The risk of the surplus leading to nutrient leaching depends on factors such as the soil's water holding capacity, hydrological conditions, climate and nutrient management practices of the farmer. The surplus is modelled in CAPRI, but the rate of leaching would have to be assessed to determine a precise effect on the environment. Nevertheless, the results give a good indication of the change in

the potential for nutrient leakage. The Baltic Sea region gets special attention because of the large problems with eutrophication in the region.

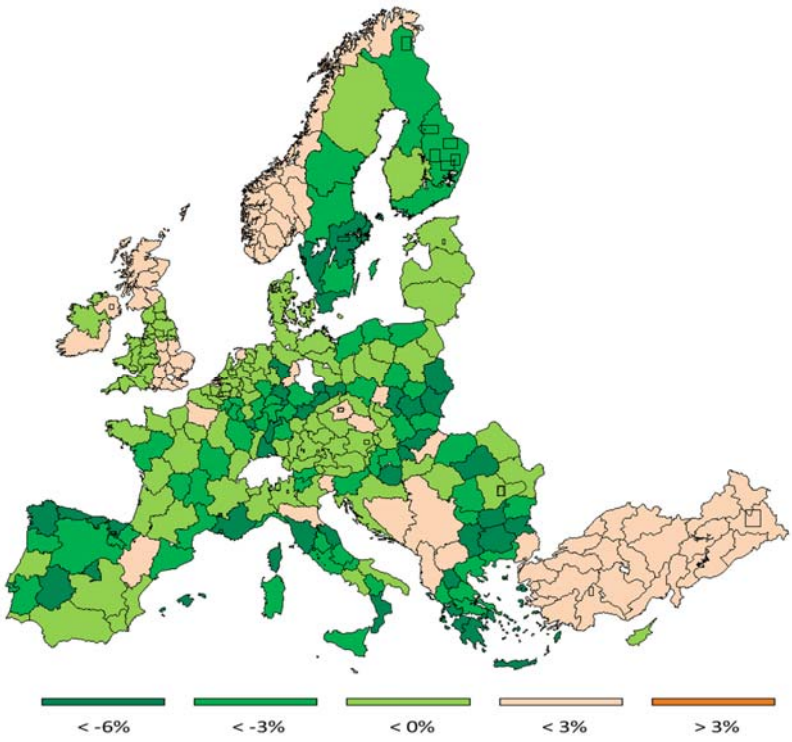


Figure 4.5 Total nitrogen surplus change in the NO DIRECT PAYMENTS scenario relative to the REF scenario, in 2025 for NUTS2 regions.

Without the direct payments, overall nutrient surpluses would be smaller, due to the reduction in agricultural activities in general. However, there are no incentives for farmers to switch to less nutrient intensive production technologies. On the contrary, as we have seen above, the remaining agricultural areas are used more intensively. Figure 4.5 shows the change in total nitrogen surplus for NUTS2 regions in Europe, where green indicates a decrease and orange an increase. Phosphorus surplus changes are similarly shown in Figure 4.6. Nitrogen surplus decreases by

2.4 per cent relative to the REF scenario in the EU on average, with regional differences mostly following the decrease in land use. However, surpluses per hectare increase by 4.4 per cent relative to the REF scenario, which makes the decrease in total surplus smaller than it potentially could have been. Phosphorus surpluses also decrease, by 2.3 per cent on average, while they increase per hectare by 4.5 per cent. The high surplus per hectare is important as it generally increases the share of surplus that leaches (Delin and Stenberg, 2012).[20]

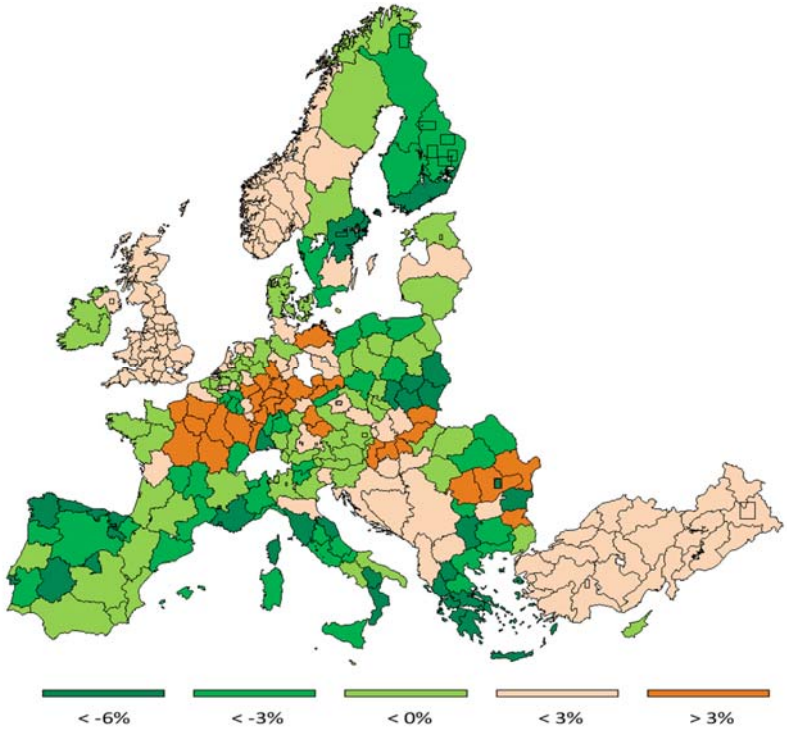


Figure 4.6 Total phosphorus surplus change in the NO DIRECT PAYMENTS scenario relative to the REF scenario, in 2025 for NUTS2 regions.

[20] Even if we cannot say for certain that any one field has an increased surplus per hectare, on the aggregate, a larger share of fields have higher surplus per hectare.

The explanation for the increase in surplus per hectare despite the overall reduction is the intensification of production. There is an increased use of fertilisers, as well as an increase in application rates. In addition, the relatively small change in animal numbers compared to the reduction in land use increases the availability of manure per hectare. As crops generally have more difficulty in taking up nutrients from manure than mineral fertiliser (Webb et al., 2013) this further increases surpluses. The result is higher surplus per hectare. For some regions and even some Member States, this leads to an increase in total surplus. Germany is one example, where phosphorus surplus per hectare increases by 9.5 per cent relative to the REF scenario and total phosphorus surplus increases by 0.4 per cent (while total nitrogen surplus decreases by 2.8 per cent).

The aggregate effect for the EU depends on the actual surplus levels. Different crops and regions use more or less fertilisers with different surplus levels as a consequence. An example is Germany, where the surplus per hectare is generally quite low, while it is high in the Netherlands. This means the impact from the Netherlands is large and despite its smaller *relative* changes in surplus levels per hectare the effect in *absolute* terms is larger than for Germany.

A consequence of lower production is larger net imports of agricultural products, which ultimately leads to larger production outside the EU, implying an increase in nutrient surpluses in non-EU countries. For the non-EU European regions covered by the detailed supply model of CAPRI, nutrient surpluses increase by around 0.4 per cent. Thus, some of the leaching problem is exported, but the implications depend on how sensitive the affected areas are.

As a special case, we look at the Baltic Sea region,[21] which has large problems with eutrophication. In 2006, out of the total regional contribution to nitrogen and phosphorus leaching into the Baltic Sea, the share

[21] Regions belonging to the Baltic Sea drainage basin were included in the calculation. This includes catchments areas to the Kattegat Sea and inwards to the Baltic Sea. For some of the CAPRI regions, only a part belongs to the drainage basin. In this case the whole NUTS2 regions surplus is included in the total surpluses. This gives, if not a totally accurate picture, a reasonable approximation of the surplus as the largest share of the regions are fully in the drainage basin.

attributable to agriculture ranged between about 25-80 per cent and 20-55 per cent respectively (HELCOM, 2010).[22] In the Baltic Sea region, nitrogen surplus decreases by 3.1 per cent when removing the direct payments in Pillar I, which is more than the EU average. Poland accounts for 61 per cent of this decrease, and is by far the largest emitter with the largest agricultural area in the region. The Polish regions also have large nutrient surpluses per hectare in relation to the other countries and therefore Poland's decrease of 3.7 per cent, relative to the REF scenario, has a large influence. For phosphorus, the decrease is 3.2 per cent relative to the REF scenario, in the Baltic region, where 88 per cent comes from Poland. In Sweden the surpluses decrease more than in Poland (by 7.0 per cent for nitrogen and by 5.7 per cent for phosphorus) since land use decreases more. However, as Sweden's total surplus is much smaller than Poland's, the contribution to the change is also smaller; 16 per cent of the total decrease for nitrogen and 4.4 per cent for phosphorus. In Germany, the increase in phosphorus surplus has only a marginal effect as the total surplus in the drainage region is small. There are only minor changes in surplus for Latvia, Estonia and Lithuania and their combined impact on the Baltic Sea is limited. In Finland and Denmark the decreases are larger and contribute to some percentages of the total decrease.

As a rough indication of the change in surplus from Belarus and Russia we look at their production change. Without direct payments in the EU, their exports to the EU and production as well as their production might be by around 0.2 per cent higher. This implies slightly higher nutrient loads from their agricultural sectors. The total surplus levels around the Baltic Sea, therefore, seems to mostly be affected by Poland, while some basins can be affected more by the change in for example Sweden and Finland.

Greenhouse gas emissions – Agriculture has an impact on climate change through emissions of different greenhouse gases (GHG), for example originating from animal digestion, manure handling, soil man-

[22] Belarus and Russia are not covered in our calculations as they are not modelled in CAPRI. Of the total nutrient load to the Baltic Sea, Belarus accounted for less than 5 per cent for both nitrogen and phosphorus in 2006, while Russia accounted for 17 per cent of the nitrogen load and 14 per cent of the phosphorus load (HELCOM, 2010).

agement and land use change. Both the size of the agricultural sector and the production mix affects GHG emissions as there are large differences in emissions intensity for different agricultural activities. CAPRI follows the IPCC guidelines (IPCC, 2006) when calculating GHG emissions from agriculture. Direct emissions of nitrous oxide and methane from agriculture are included, but not emissions of carbon dioxide or from land use change, which are accounted for elsewhere.

Without Pillar I direct payments, GHG emissions from agriculture decrease by 2.5 per cent in the EU relative to the REF scenario, following the decrease in agricultural activity, and in particular animal husbandry. Figure 4.7 illustrates the change, where emissions from different sources and gases summed together by expressing them in carbon dioxide equivalents (CO_2eq).[23]

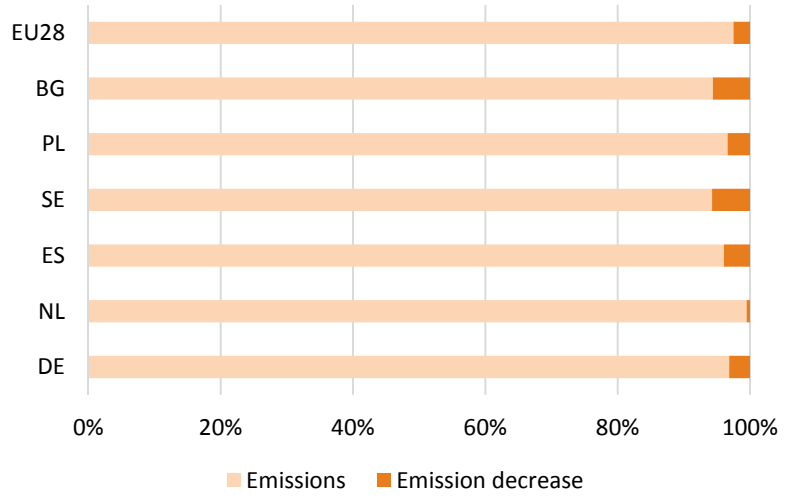


Figure 4.7 Agricultural GHG-emissions in the NO DIRECT PAYMENTS scenario compared to the REF scenario, in 2025.

[23] Carbon dioxide equivalents (CO_2eq) is a measure used to roughly compare emissions from different types of greenhouse gases.

Figure 4.8 shows the change in agricultural GHG emissions for the EU and the rest of the world. The first bar shows the share of the decrease in emissions from important sectors in EU agriculture.[24] Due to low emissions intensity, the fall in crop production accounts for a smaller share of the decrease in GHG emissions. Instead, it is the animal sectors that are the main drivers of the decrease. Although the number of animals in the dairy sector decreases by only 1.4 per cent relative to the REF scenario, about 21 per cent of the decrease in emissions is attributable to dairying, because of its large emissions of methane and the relatively large size of the sector. The smaller beef cattle sector also emits large amounts, and 29 per cent of the total decrease in GHG emissions follows from a 4.8 per cent decrease in production in the sector. The large decrease in pasture, an input to animal production, accounts for another 34 per cent. This is due to a large change in grassland, where emissions come mainly from synthetic fertiliser on certain grasslands and crop residues that emit nitrous oxide into the air through various processes. Sheep and goats account for 6.3 per cent of the decrease. In Sweden, GHG emissions fall by 5.7 per cent, primarily caused by the decrease in beef cattle. In the Netherlands the decrease is only 0.5 per cent, because changes in dairy production are limited, and the decline is furthermore counteracted by a small *increase* in beef cattle production.

GHG emissions are affected by the choice of production system as well as the type of production. Per-hectare emissions from agricultural land increase by 3.4 per cent relative to the REF scenario when intensity increases. This reduces the effect of less land being used. On the other hand, emissions per tonne of product decrease as inputs change and production becomes more intense. The logic is that the increase in yield for a specific product is met by a lower increase in emissions per hectare or per animal, or unit of associated inputs. This implies that under the same production mix and quantities, total emissions can be lower. In Germany, where beef cattle numbers decrease by only 1.7 per cent, total GHG emissions are reduced by 3.1 per cent. Here, the beef sector is smaller than the EU average and changes in other sectors, like dairy and fodder production, are more important for the total emissions. In Spain,

[24] There are only minor increases in a few sectors, not visible in the graph.

where the total decrease in GHG emissions is 3.9 per cent, both a reduction in beef cattle numbers and in emissions per tonne of output contributes to the decrease. On the other hand, the Spanish beef and dairy sectors are quite small, and most emissions come from other animals, where the production change is small.

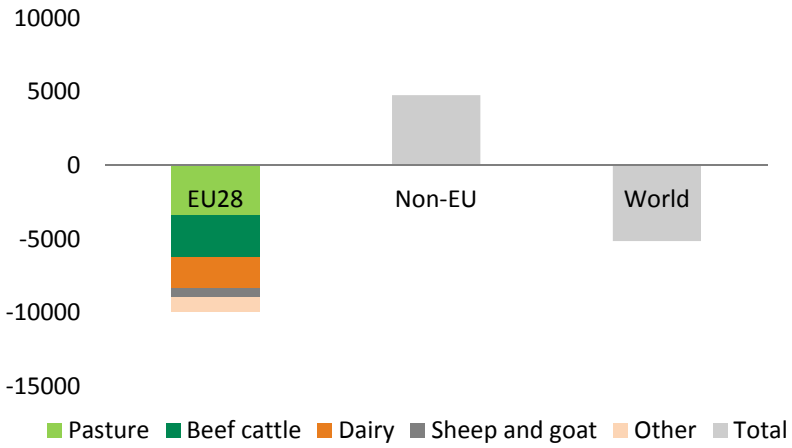


Figure 4.8 GHG emissions, absolute change and each sectors relative contribution to the change in the NO DIRECT PAYMENTS scenario compared to the REF scenario, in billion t CO2eq in 2025.

As climate change is a global problem, the effect on world agricultural GHG emissions is important. Figure 4.8 illustrates how reduced GHG emissions from the EU are counteracted to some extent by increased emissions in other countries. The changes are shown in absolute numbers, where EU emissions decrease by 9.9 billion tonnes CO_2eq per year, while at the same time non-EU countries increase emissions by 4.8 billion tonnes CO_2eq. The net result for world GHG emissions is consequently a decrease of 5.1 billion tonnes CO_2eq – a little more than half of the decrease in the EU. This is caused by an increased import of agricultural commodities to the EU, as EU production decreases while consumption only changes a little. Nevertheless, consumption of the emission-intensive beef falls by 1.1 per cent, implying that not all of the EU reduction in emissions is counteracted by an increase outside the EU.

The decline in emissions per product also reduces emissions in general. The global effects also depend on specific trading patterns as emissions for the same product are different across countries in the world. Direct payments thus contribute to higher global GHG emissions.

Biodiversity and food security – Changes in land use are important as preservation of agricultural land can be beneficial for biodiversity, (see Box 2.4). In particular, diverse agricultural land uses and marginal land are important. The land use decrease in the NO DIRECT PAYMENTS scenario is thus problematic especially as the, generally, more marginal pasture areas decreases more than arable land. There is also increased intensity of farming, which could have further negative impacts on biodiversity. In CAPRI no explicit biodiversity indicator is computed, but a biodiversity analysis is provided in chapter 5, using the AgriPoliS model.

Food security is also threatened, since decreases in agricultural land use today that lead to land abandonment reduce future production potential.

Impacts on agricultural incomes and the CAP budget

Just as agriculture and the CAP have effects on the structure of European agriculture and the environment, it affects the people living in the EU; those who earn their income in agriculture, tax-payers who finance the CAP, and consumers buying food. In this section we discuss the welfare[25] effects of direct payments.

The direct payments constitute a large transfer of income from tax payers to farmers. Conversely, removing them would naturally impact farmers' incomes negatively. At the same time increased intensity and higher output prices increase sales revenues, making up for some of the lost support. In the NO DIRECT PAYMENTS scenario, total agricultural income in the EU decreases by 21 per cent, or €36 billion, relative to the REF scenario. This is illustrated in Figure 4.9. There are differences among regions; in Spain, where a comparably large share of income comes from vegetable, olive and fruit production that are relatively unaf-

[25] Here, we use the term "welfare" in the narrow view common in economic analyses. In particular, it does not include considerations like human health or social security.

fected, income is only decreasing by 12 per cent. For countries like Germany, the Netherlands, Spain and Poland, sales revenues actually increase as agriculture changes to more competitive production at higher prices, but as the support decrease is large the result is a net decrease in income.

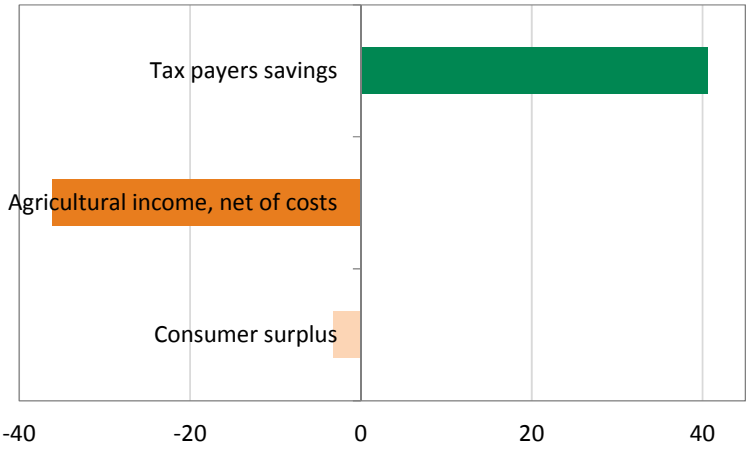


Figure 4.9 Change in welfare indicators in the NO DIRECT PAYMENTS scenario compared to the REF scenario, in billion euro in 2025.

While income decreases, the taxpayers save €41 billion annually relative to the REF scenario when direct payments are removed. This can be compared to the total EU budget in 2017 of €156 billion.[26] Increased trade also increases revenues from trade tariffs. Consumer prices do not change as much as producer prices, but increase by around 0.3 per cent, which affects consumers slightly negatively. The effect is a decrease in consumer surplus by €3 billion relative to the REF scenario. This implies that the total negative economic impacts of direct payments are larger than the positive impacts. The combined effect on welfare depends on how the released production factors, land, labour and capital are used. Consequently, we conclude that the direct payments lead to redistribu-

[26] http://ec.europa.eu/budget/mff/figures/index_en.cfm

tions, mainly from tax payers to producers but also from producers to consumers, and that they imply an overall welfare loss.

4.3 PUBLIC GOODS scenario – replacing direct payments in Pillar I with targeted payments for marginal land

A negative consequence of removing Pillar I direct payments is abandonment of less productive land, predominantly in marginal areas. In the PUBLIC GOODS scenario a payment is targeted on marginal land, and for modelling reasons, to better reach the preferred type of land, it is furthermore targeted on extensive production. The payment is a compensation for the public goods farmers provide by managing marginal land, and is thus an application of the Provider Gets Principle. It provides an economic incentive to manage land that does not provide sufficient market returns, but that is potentially important for biodiversity and potentially for food security. For a description of the scenario, see section 3.2. Both in reality and in the model it is difficult to be exact in the definition of which land is eligible for the payment, which reduces the exactness of the results. Land abandonment is though analysed in more detail in the ensuing AgriPoliS simulations.

Results are discussed relative to the REF scenario, but as the scenario is also to be seen as an improvement on the NO DIRECT PAYMENTS scenario, these too are compared when instructive. By introducing the payment for marginal land, land use is affected to a smaller extent than in the NO DIRECT PAYMENTS scenario, while the CAP budget is still reduced compared to the REF scenario.

Changes in agricultural support

In the PUBLIC GOODS scenario the support per hectare is set to be the average of the total direct payments in Pillar I in each Member State, which means that 60 per cent of the Pillar I budget in the REF scenario remains. As the new support depends on how much marginal land there is in the respective regions, changes in support differ among regions; in Dusseldorf in Germany support decreases by 88 per cent compared to the REF scenario, while in Castilla-La Mancha in Spain it increases by 10

per cent.[27] Non-marginal land, which is not providing the same kind of public good benefits for society, is not eligible for any payments. In the model however marginal and non-marginal land cannot be distinguished, only the share of marginal land in a region. Just as in the NO DIRECT PAYMENT scenario, there is no support to animals.

Impacts on land use

In response to the public-goods payment, agricultural land use decreases by only 1.7 per cent compared to the REF scenario. Pasture decreases by 3.4 per cent, avoiding the large decrease (11.6 per cent) in the NO DIRECT PAYMENTS scenario. Arable land decreases with 0.8 per cent compared to the REF scenario. The changes in land use for the NUTS2 regions compared to the REF scenario are shown in Figure 4.10 and Figure 4.11. As examples, agricultural land use decreases by 2.8 per cent in Bulgaria while, in the Netherlands, it decreases by only 0.7 per cent. In general, areas that receive more of the public-goods payment have lower levels of land abandonment or even an increase in land use, compared to the REF scenario.

[27] Spain applies "partial convergence" in the reference scenario. Therefore, the payment rate (Individual Unit Values) in this region were lower than the national average. With the new support to marginal land, the rate per hectare is the national average, and therefore the support levels would increase.

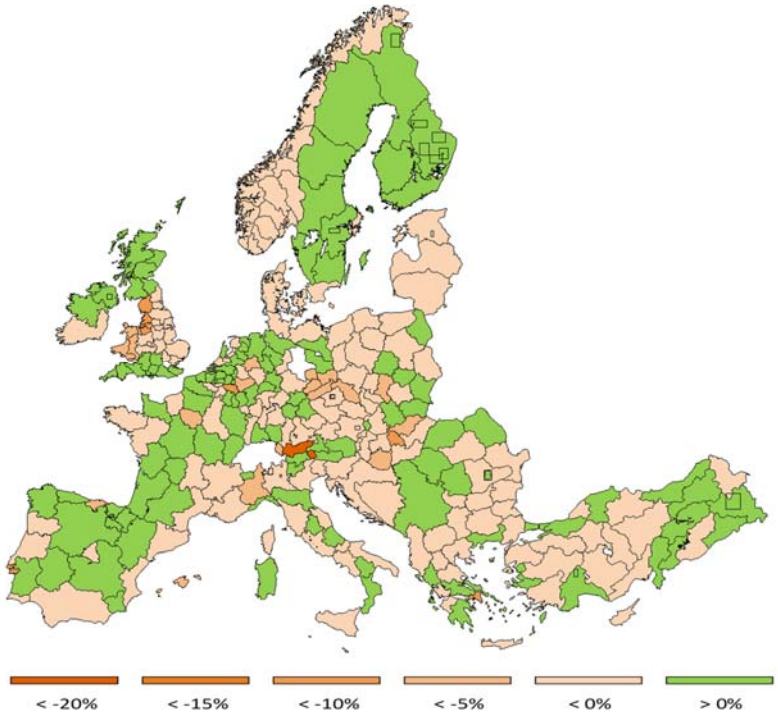


Figure 4.10 Change in arable land in the PUBLIC GOODS scenario relative to the REF scenario, in 2025 for NUTS2 regions.

Note: The agricultural area is not necessarily proportional to the area on the map, as agriculture is only one of many land uses in each region.

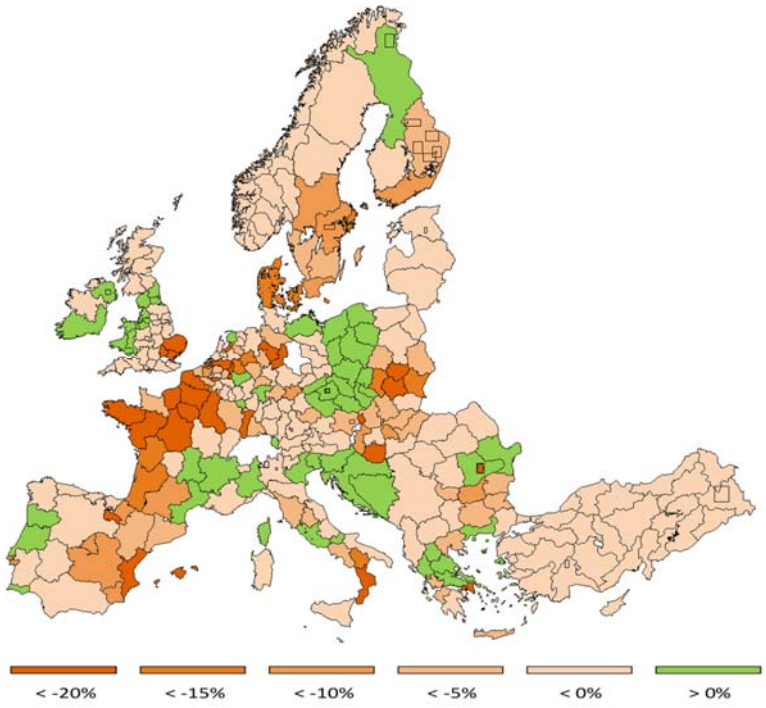


Figure 4.11 Change in pasture in the PUBLIC GOODS scenario relative to the REF scenario, in 2025 for NUTS2 regions.

Note: The agricultural area is not necessarily proportional to the area on the map, as agriculture is only one of many land uses in each region.

There are also shifts in land use within the arable land category: land used for cereals and fodder production *increase*, compared to the REF scenario. Fallow land, in contrast, decreases, albeit by less than in the NO DIRECT PAYMENTS scenario. Because the requirements for the Greening Payment to keep Ecological Focus Area (EFA) is eliminated, activities that count as EFA such as fallow land, become less attractive and land is released for other activities. Which activities these are depends on the regional characteristics, for instance suitability for different crops and the amount of payments for marginal land that is assigned to the region.

Impacts on production

The supply of agricultural products is almost the same in the PUBLIC GOODS scenario as in the NO DIRECT PAYMENTS scenario, but for other reasons. In this scenario, a payment is given to marginal land which is generally less productive, and the support is directed to extensive farming. This results in lower overall agricultural productivity. Compared to in the NO DIRECT PAYMENTS scenario productivity decreases, as preserving marginal land implies a smaller fall in output. This, in turn, implies that output prices do not increase at the same rate and, thus, that intensified production is less profitable. In addition, intensity decreases compared to the REF scenario, where the present CAP is modelled, as the payment targets extensive production methods. In combination with small changes in land use, the change in output of crops is comparable to that in the NO DIRECT PAYMENTS scenario. Changes in animal numbers are also similar, because the coupled support to livestock production (VCS) is absent also in the PUBLIC GOODS scenario. Feed prices decrease compared to the NO DIRECT PAYMENTS scenario, but on the other hand animal production becomes less profitable relative to just doing the minimum to fulfil the Basic Provisions.

Impacts on the environment

Biodiversity and food security – The aim of the payment for marginal land is to avoid abandonment of land that is potentially valuable for conserving biodiversity and food security. For regions with a relatively large share of marginal land, like many parts of Sweden, most of the land abandonment observed in the NO DIRECT PAYMENTS scenario is avoided, and in some cases land use increases in the PUBLIC GOODS scenario. Overall, agricultural land use decreases somewhat compared to the REF scenario, but much less than in the NO DIRECT PAYMENTS scenario. Further, both pasture and arable land are managed less intensively in the PUBLIC GOODS scenario compared to the REF scenario, which is also positive for biodiversity and for reducing polluting emissions. Biodiversity impacts are analysed with AgriPoliS in chapter 5.

Nutrient surplus - Another effect of the PUBLIC GOODS scenario is that nutrient surpluses decrease more than in the NO DIRECT PAYMENTS scenario. Total nitrogen surplus decreases by 5.2 per cent and phosphorus by 7.1 per cent compared to the REF scenario. The relatively small change in land use, which could imply small changes in surpluses, is accompanied by less intensive use of the land, which is tied to reduced nutrient surpluses per hectare. Nitrogen surplus *per hectare* decreases by 3.6 per cent and 5.5 per cent for phosphorus, which can explain much of the decrease in total surpluses. The lowered surplus per hectare is important as it generally reduces the share of surplus that leaches away.

Greenhouse gas emissions - Agricultural GHG emissions decrease by 11.6 billion tonnes CO_2eq or 2.9 per cent, compared to the REF scenario, which is also more than in the NO DIRECT PAYMENTS scenario. This can be explained by less overall production. The reduction at the global level is also larger; emissions decrease globally by 6.5 billion tonnes CO_2eq. The main explanation is mainly that even if consumption is at the same level, the demand for and use of feed decreases, and with it emissions of GHG.

Impacts on agricultural incomes and the CAP budget

As farmers receive more support in the PUBLIC GOODS scenario than in the NO DIRECT PAYMENTS scenario, total agricultural income decreases by only €12 billion annually, compared to €36 billion in the NO DIRECT PAYMENTS scenario. On the other hand, tax payers save less too, €15 billion, while consumer surplus decreases by €3 billion.

4.4 TAX scenario – removing direct payments and introducing a fertiliser tax

In the NO DIRECT PAYMENTS scenario, total nutrient surplus decreases, but only moderately, and surpluses per hectare increase. We therefore explore if a nutrient tax on mineral fertilisers can reduce surpluses of nitrogen and phosphorus further. This is an example of the Polluter Pays Principle (see Box 2.5). The tax is targeting the source of the pollution, the fertiliser, but in this case only one of the sources. We tax mineral fertiliser as this is traded and easier to tax than manure which is also

used for fertilising. In this way we get close to paying for polluting. A tax on the actual leaching of nutrients would have been more exact, but evaluating such a result-based scheme is beyond the scope here. The tax increases the price of mineral fertilisers by 25 per cent. As the price rises, fertilising becomes more expensive, and the farmer gets an economic incentive to change his production to use less mineral fertilisers. Thus we expect nutrient surpluses to decrease.

Changes in agricultural support

In this scenario, support decreases by as much as in the NO DIRECT PAYMENTS scenario, but in addition, the tax can be seen as a negative support. With the tax included, total support (according to CAPRI) decreases by 90 per cent in the EU compared to the REF scenario. The tax targets nutrients, and the average tax for a specific crop and region depends on how much fertiliser is used. A crop needing a lot of nutrients is therefore taxed more heavily, and a region where farms use large amounts of fertilisers to increase production would pay larger amounts of taxes. The availability of manure fertiliser also influences the results, as this is not taxed.

Impacts on land use

In the TAX scenario, land use decreases by 7.3 per cent relative to the REF scenario which is somewhat more than in the NO DIRECT PAYMENTS scenario. Arable land decreases by 4.9 per cent and pasture decreases by 12.0 per cent. However, compared to the NO DIRECT PAYMENTS scenario, the relative effect on arable land is larger than that on pasture. As crops use more fertilisers than pasture these are more affected. Land use in sectors with a large use of fertiliser is particularly affected. This leads to a decrease in land used for example for sugar beets and intensive pasture, while land such as extensive pasture and fodder production decrease less than in the NO DIRECT PAYMENTS scenario.

Impacts on production

Output of crops decreases in the TAX scenario compared to the REF scenario. In the NO DIRECT PAYMENTS scenario more intensive use of inputs per hectare of land is profitable, and this effect is present in the TAX scenario too, which is also without direct payments. But, in this

scenario the increase in fertiliser input is moderated. Thus production is intensified, but to a lesser extent than in the NO DIRECT PAYMENTS scenario. The result combined with reduced land use is that output from crop production decreases even more than in the NO DIRECT PAYMENTS scenario, resulting in larger imports. There are only small additional decreases in livestock production when the fertiliser tax is introduced compared to the NO DIRECT PAYMENTS scenario. This is because animal production does not directly require fertilisers, but rather indirectly via feeding stuffs. The feed cost increase due to the fertiliser tax is less than the tax rate, implying that costs increase by less than in crop production.

Impacts on the environment

Nutrient surplus - The nutrient surplus decreases more than by simply removing the direct payments, because lower fertiliser input rates are used and there is a larger decrease in land use. Nitrogen surplus decreases by 4.8 per cent relative to the REF scenario, and the surplus increases per hectare, but only by 2.7 per cent which is about half the increase per hectare surplus in the NO DIRECT PAYMENT scenario. Phosphorus decreases by 5.3 per cent relative to the REF scenario while the surplus per hectare increases by 2.1 per cent. The lowered surplus per hectare is important as it generally reduces the share of surplus that leaches away. The changes in total surplus levels are illustrated in Figure 4.12 and Figure 4.13. In the NO DIRECT PAYMENTS scenario, mineral fertiliser use per hectare increases, but this increase is not occurring in the TAX scenario. On the other hand, fertiliser from manure increases per hectare. This is explained by the increase in livestock density compared to in the NO DIRECT PAYMENTS scenario.

The reader that compares the impacts on nutrient surplus in TAX to that in PUBLIC GOODS in Table 4.1 may note that the latter is larger, which may seem odd. There are several explanations. Firstly, the amount of tax cannot easily be compared to the amount of subsidy in the PUBLIC GOODS scenario. A higher tax or lower subsidy might have reversed the relationship. Secondly, the fertiliser tax only works on the synthetic fertilisers, creating an incentive to use more manure instead. Manure is less efficient than synthetic fertiliser when it comes do delivering nutrients to

crops when the crop needs them, and the nutrients are much less available in manure than in synthetic fertilisers, as explained by e.g. Webb et al. (2013). Finally, the reader should keep in mind that the payment in PUBLIC GOODS in CAPRI is defined as a subsidy to extensive farming activities, by requiring less nutrients (be it manure or synthetic fertilisers) for lower yield levels.

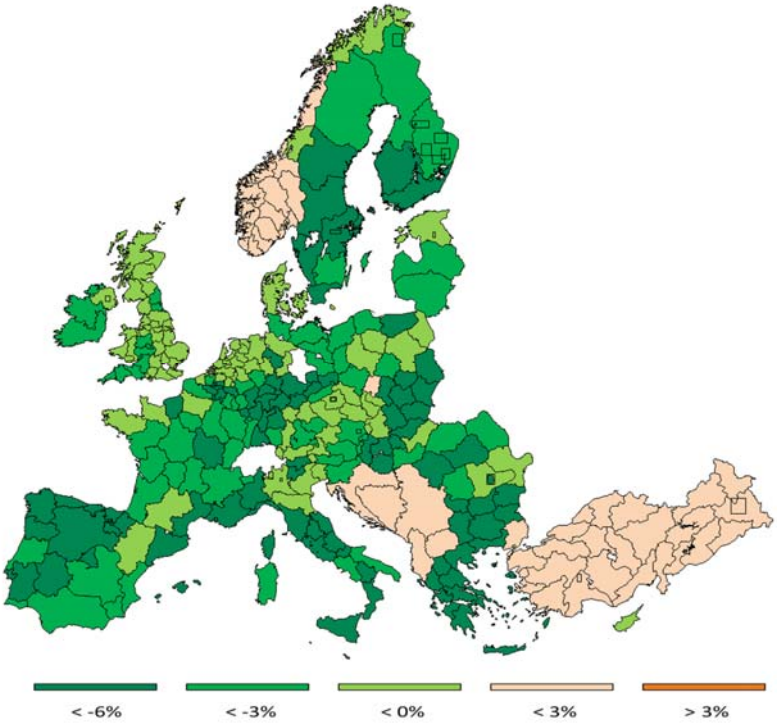


Figure 4.12 Total nitrogen surplus change in the TAX scenario relative to the REF scenario, in 2025 for NUTS2 regions.

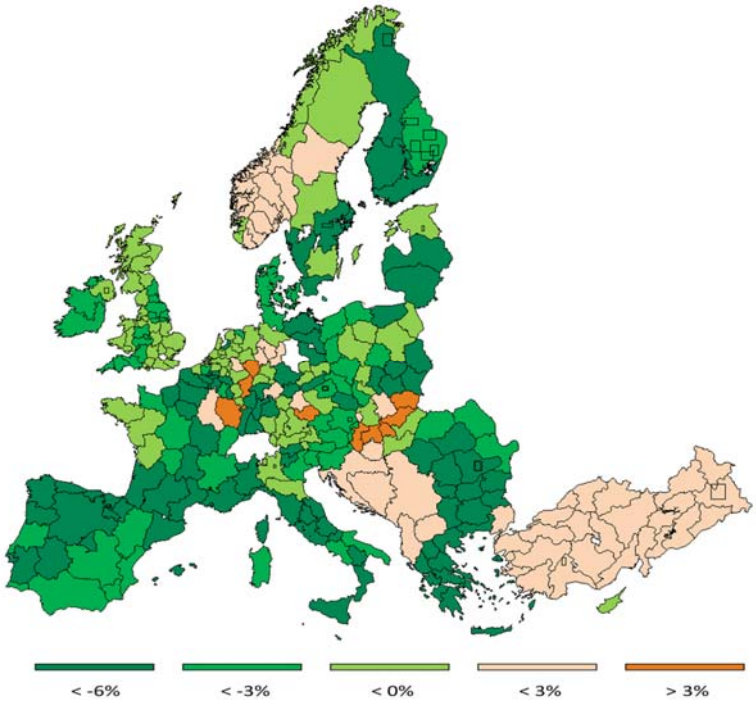


Figure 4.13: Total phosphorus surplus change in the TAX scenario relative to the REF scenario, in 2025 for NUTS2 regions.

Greenhouse gas emissions – The reduction in land use results in less agricultural GHG emissions, with a decrease of 3.6 per cent compared to the REF scenario, which is also a larger decrease than in the NO DIRECT PAYMENTS scenario. This is primarily caused by the reduced use of mineral fertilisers. The reduction in the EU is 14.5 billion tonnes CO_2eq (9.9 billion tonnes CO_2eq in NO DIRECT PAYMENTS scenario). On the other hand, emissions outside the EU are larger than in the NO DIRECT PAYMENTS scenario; 5.7 billion tonnes CO_2eq compared to 4.8 billion tonnes CO_2eq in NO DIRECT PAYMENTS. The larger decrease in the EU outweighs this however, and in total global emissions decrease by 8.8 billion tonnes CO_2eq compared to the REF scenario.

Biodiversity and food security – The decrease in land use indicates a potentially negative effect on biodiversity compared to the REF scenario. Intensity in farming also increases which could further affect biodiversity. Compared to the NO DIRECT PAYMENTS scenario, land use changes more, which could indicate a larger decrease in biodiversity, but at the same time the increase in intensity is lower, and pasture is affected to a lesser extent. For food security the large land use decrease has a negative impact.

Impacts on agricultural incomes and the CAP budget

In addition to losing direct payments farmers have to pay the tax, resulting in a decline in agricultural incomes in the EU by €39 billion. This is €3 billion more than in the NO DIRECT PAYMENTS scenario. On the other hand, tax-payers save more than in the NO DIRECT PAYMENTS scenario; the decrease in support and increased income from the tax means that €45 billion is saved, which is €4 billion more than in the NO DIRECT PAYMENTS scenario. Consumer surplus decreases by €5 billion.

5 Results of the AgriPoliS simulations

The great diversity in European agriculture has already been stressed multiple times in this study. The differences are likely to produce a wide variety in results at regional and local level that are not captured in the macro-level analysis in chapter 4. In order to explore the impact of Pillar I direct payments at a more detailed level, thereby complementing the European-level study, we perform a case study of Sweden using corresponding scenarios. Employing the agent-based simulation model AgriPoliS, we simulate structural development and its environmental consequences for four typical agricultural regions in Sweden. The diverse characters of these study landscapes and the regional differences in agricultural conditions provide results that to a degree can be generalised to agriculture in other member states with similar conditions.

We begin by a summary of the findings from this part of the analysis. A summary of the simulation results can be found in Table 5.1.

5.1 Summary of results

The Swedish case studies accentuate the main findings from the previous chapter; there are large regional variations in the effects of Pillar I direct payments on the use of agricultural land. While only 8 per cent of agricultural land is abandoned in the highly productive intensive-cropping region without direct payments, around 60 per cent is abandoned in the livestock-dominated mixed-forestry region. This is because high-yielding land is not dependent on payments, because it is profitable to farm based on market returns alone; whereas marginal land is not profitable and hence abandoned. In this way the Pillar I direct payments are currently contributing to preserving marginal agricultural land.

In turn, abandonment of marginal agricultural land results in large reductions in the provisioning of public goods. Many threatened species are dependent on the continuation of extensive farming practises that are often associated with marginal land, hence abandonment of this land is damaging to biodiversity. The regions most affected by biodiversity decline are those rich in semi-natural pasture, which is particularly important for biodiversity. Biodiversity declines by 23 per cent in the mixed-forestry region and 11 per cent in the mixed-farming region without direct payments. Other public goods negatively affected by land abandonment are food security and cultural heritage values associated with preservation of traditional agricultural landscapes. In this way direct payments are currently contributing to the provisioning of public goods, but primarily from marginal agricultural land.

The case studies also show that the impact of direct payments on agricultural land use is stronger than that on production. Generally, there is more production in the extensively farmed regions, mainly in the beef and dairying enterprises, with direct payments than without. In the more intensively farmed regions land use is largely unaffected by direct payments, but crop production is somewhat less intensive with direct payments, as a consequence of the lower output prices associated with higher EU supply (predicted by CAPRI). In crop production this means lower application rates of fertilisers and pesticides. The extensification-of-production impact was also found generally in the EU-level analysis. Consequently, direct payments result in greater production in marginal regions, and more extensive production generally.

The impacts on production and input intensity have, in turn, environmental consequences, the direction and size of which also vary greatly among regions. In general, where production is greater so are the negative environmental effects of agriculture, and vice versa. In the intensive-cropping region GHG emissions, nutrient surpluses and chemical inputs are lower with direct payments, because intensive livestock production, such as pig fattening, decrease. However the reverse occurs in the other three regions; cattle production and hence GHG emissions, nutrient surpluses and chemical inputs increase. Consequently, the impacts of direct

payments on environmentally damaging emissions in our study regions are both positive and negative.

The AgriPoliS simulations show that direct payments have a substantial impact on structural change. These effects cannot be disaggregated in the CAPRI results, as CAPRI does not model individual farms. The number of farms decline by between 35 and 86 per cent in all four study regions without direct payments. The largest decline takes place in the high-productive regions, where remaining farms simultaneously grow substantially. The opportunity to grow is provided by the exit of less productive farms, which leads to the increased supply of high-yielding land on the market. Fewer and larger farms in turn results in higher farm incomes. However, in the low-productive regions farms do not grow much in size in the absence of direct payments, owing to the low productivity of the land released by exiting farms. These results demonstrate that direct payments are significantly slowing the process of structural change. This restricts the development of competitive farms in relatively productive regions.

By simulating a payment for marginal agricultural land (the PUBLIC GOODS scenario) in the place of direct payments, we demonstrate that it is possible to avoid the abandonment of marginal land and loss of associated public goods that occurs in the absence of direct payments. Here too there is some intensification of farming, due to the higher output prices on the world market brought about by the reduced EU production. The effects are largest in the most productive regions; nitrogen surplus and polluting emissions of GHG and pesticides increase. However, these results should not be interpreted as a case against a payment for public goods; the payment is not designed to solve problems of nutrient surplus or polluting emissions of GHG or pesticides, but to target biodiversity and preserving agricultural land in low-productive regions. Rather, additional policy instruments are needed to address emissions concerns. (For an analysis of an instrument that targets nutrient surplus, see the TAX scenario in chapter 4.)

Table 5.1 Summary of results from the Swedish case-study.

	Subarctic		*Mixed-forestry*		*Mixed-farming*		*Intensive-cropping*	
Scenario	NO DP	PG	NO DP	PG	NO DP	PG	NO DP	PG
Land use	-40%	0%	-62%	0%	-42%	0%	-8%	0%
Production								
Arable crops	-18%	7%	-40%	5%	-17%	28%	1%	1%
Grassland	-44%	-1%	-67%	-1%	-62%	-23%	-65%	-4%
Beef cattle	-55%	-21%	-94%	-16%	-54%	7%	-34%	-40%
Dairy cows	-13%	1%	-7%	-5%	-6%	49%	113%	175%
Pigs	N/A		N/A		54%	104%	145%	178%
# of farms	-35%	-3%	-68%	-10%	-86%	-90%	-79%	-81%
Farm size	-8%	4%	19%	11%	325%	858%	338%	415%
Farm income	37%	-6%	99%	39%	383%	406%	138%	163%
Biodiversity	-2%	0%	-23%	0%	-11%	0%	N/A	N/A
GHG emissions	-27%	-5%	-14%	-9%	-27%	26%	8%	14%
Nutrient surplus								
Nitrogen	-36%	-1%	-68%	-222%	-44%	26%	14%	17%
Phosphorus	-24%	-15%	16%	-179%	-13%	-79%	-85%	-123%
Pesticides								
Herbicides	-59%	1%	-46%	18%	-41%	6%	-7%	-1%
Fungicides	-18%	7%	-40%	5%	-13%	24%	1%	0%
Insecticides	-18%	7%	-40%	5%	-22%	40%	1%	0%

5.2 Important mechanisms modelled in AgriPoliS

Throughout the presentation and analysis of the simulation results, a number of explanations for different findings will reoccur. These are basic mechanisms modelled in AgriPoliS that are linked to the CAP via farmers' decision-making, and that will influence the results. Therefore we devote the five following boxes to stating and briefly explaining the mechanisms, with no ranking of importance, and their consequences for farm agents' decisions (i.e. model results), and will refer back to these as the results are presented.

Box 5.1 The price of agricultural land

The rental price of agricultural land can be higher due to direct payments. This is because 1) the supply of land on the land market is affected by the rate at which farmers are leaving the sector, which can be slowed by direct payments, and 2) payments can capitalise in land prices through farm-agents' competition for available land. Capitalisation results from a direct payment raising the revenue from farming land, regardless of the productivity of the land. Higher rental prices disadvantage expanding farms as it increases the costs of acquiring more land and hence the costs of farming. Thus higher land rental prices can offset the higher revenue that is provided by direct payments.

Box 5.2 World market prices

A change in agricultural production will, if the change is large enough, lead to a change in prices of agricultural products on the world market, following standard economic theory of supply-demand dynamics. When a new equilibrium price and quantity is reached, it is possible that the relative profitability of different agricultural enterprises changes. If a change in relative profitability occurs, it is followed by an adjustment of supply towards more of the good that has become relatively more profitable. Consequently, potential changes in production brought about by direct payments are likely to be moderated by changes in output prices (which is predicted by CAPRI, see section 4.2).

Box 5.3 Continuing farming: the opportunity cost condition

The *opportunity cost* of farming is the profit a farm-agent must achieve for farming to be the best use of the family's own labour and capital. If profits from farming do not exceed the farm's opportunity costs the condition of not fulfilled, meaning that there is a better use of the resources in another sector and an income-maximising household would choose that alternative over farming. For farms on the margin, the direct payments can raise profits from farming over this bar, thus making farming the best use of the family's resources (i.e. to maintain the farm rather than closing down and releasing land to the land market). Therefore direct payments can keep more farms going than would otherwise occur, because they raise farm profits above the opportunity cost threshold. If the condition is not fulfilled, farmers have three main strategic routes available to them in AgriPoliS, to boost family income: i) expand the farm area to exploit economies of scale, which is made possible by some farms quitting, ii) reduce their farm area and intensify production, or iii) quit farming and work and invest outside the sector.

i) Farming is characterised by economies of scale, meaning that larger farms generally have lower operating costs per hectare. This is particularly true for crop farms. Once the initial investments in buildings and machinery have been made, the additional cost of farming another hectare is small. Therefore a principal course of action to increase income is to *rent additional land* and expand production. However, since farmland is scarce in our regions, some farms must close down and release their land to allow others to expand.

ii) The second option is to *reduce the farmed area* and intensify production on the farmed area. Because the basic and greening components of the direct payments are paid per hectare, they are essentially subsidies to land, because they increase the relative profitability of using more land in production, i.e., extensification of farming. In the absence of direct payments it could therefore be more profitable to reduce the farm area and increase productivity on the remaining hectares, i.e. intensify production. For example, beef cattle can be raised more extensively on pasture or kept in stables and fattened on grains. The incentive to intensify is strengthened if output prices also increase as a result of reduced aggregate EU supply (see below).

iii) The final course of action is to *quit* farming. A farmer who cannot fulfil the opportunity cost condition either by exploiting increasing returns to scale or intensifying production, will quit farming (in our model). This leads to the release of land to the rental market, making it available for farmers pursuing expansion.

Box 5.4 Minimum agricultural activity requirement

The Basic Provisions for eligibility for Pillar I direct payments include a minimum activity requirement, requiring farmers to perform some minimal amount of agricultural activity on the land (Regulation (EU) No 1307/2013). This provides an incentive to keep land in agricultural use, as long as the direct payment and the returns from the land, if any, together exceed the cost of meeting the activity or maintenance requirement. Without the activity requirement, there are no incentives to manage marginal land, which will result in agricultural land being abandoned in AgriPoliS. The Basic Provisions are discussed in Box 2.2.

Box 5.5 Production effects of decoupled payments

Despite the decoupling of direct payments from production after the 2003 reform, indirect links between payments and production remain. First, to fulfil the minimum activity requirement and be eligible for direct payments, farmers need to perform some agricultural activity in order to keep agricultural land in good condition. Income maximising farmers will choose the most cost-efficient way of doing so, which may be by keeping grazing livestock on the land. The decoupled payment is thereby indirectly linked to a larger production of livestock in this case, via the activity requirement. Secondly, direct payments influence whether farms continue in operation or not via the opportunity cost condition. If farms remain in operation as a result of the additional revenue provided by the payments, they may continue with production. On the other hand, if a farm closes down there may not be another farmer willing to take over the land and it will be abandoned.

5.3 NO DIRECT PAYMENTS scenario – analysing the impacts of the current Pillar I direct payments

This section is devoted to analysing the impacts of Pillar I direct payments on land use, production, agricultural structure and environmental indicators in the four study regions. The impacts are quantified by comparing a scenario where the agricultural policy continues unchanged through to 2025 (REF), to a scenario without direct payments (NO DIRECT PAYMENTS). The scenarios are described more fully in Box 3.1. We begin by describing how support changes in the four regions in these scenarios.

Changes in agricultural support in Sweden

Direct payments represent substantial policy support to farmers in Sweden. To better understand and interpret the results presented in the next section, we here provide a brief description of current support levels in the Swedish study regions (REF) and how they change in the NO DIRECT PAYMENTS scenario (NO DP). The support levels are summarised in Table 5.2.

Table 5.2 Annual Pillar I direct payments in AgriPoliS in 2025 in the REF and NO DIRECTS PAYMENTS (NO DP) scenarios.

	Subarctic		*Mixed-forestry*		*Mixed-farming*		*Intensive-cropping*	
Scenario	REF	NO DP	REF	NO DP	REF	NO DP	REF	NO DP
Basic payment	€135	-	€135	-	€135	-	€135	-
Greening Payment	€58	-	€58	-	€58	-	€58	-
Coupled cattle payment (per animal older than 1 year)	€91	-	€91	-	€91	-	€91	-
LFA payments*	€115 to €231	€115 to €231	€52 to €105	€52 to €105	-	-	-	-
Milk support (per dairy cow)	€701	€701	-	-	-	-	-	-

* The upper bound is the amount given to grassland not exceeding 200 ha/farm (for grassland types 1-3) and not exceeding 70 ha/farm (for type 4 and arable land).

Firstly, because of the ongoing harmonisation of the basic payment scheme, all Swedish farmers will have the same amount of basic payments per hectare in 2019. In the NO DIRECT PAYMENTS scenario we remove the basic payment scheme, together with the minimum activity requirement in 2020, for comparison with the REF scenario. As discussed in Box 5.5 above, there still remains a number of mechanisms linking di-

rect payments and the associated minimum activity requirement to farmers' production decisions, despite the support being, ostensibly, decoupled from production. Further the Greening Payment is also eliminated, which affects all farmers receiving Pillar I payments, as the Greening Payment constitutes a constant share of the basic payment. The greening conditions also disappear, which in practice only affects farms in the mixed-farming and intensive-cropping regions, which will no longer be required to establish EFA's. In contrast, removing the Voluntary Coupled Support to cattle will only affect cattle producers.

Finally, Pillar II and Nordic Aid payment schemes are held constant in both scenarios. The main beneficiaries of these systems are farmers in the subarctic and mixed-forestry regions, who consequently will keep some support even in the NO DIRECT PAYMENTS scenario.

Impacts on agricultural structure

A main consequence of eliminating the direct payments is a large reduction in the number of farms in all regions. Figure 5.1 shows the difference between the REF and NO DIRECT PAYMENTS scenarios over three dimensions; number of farms in each region (horizontal axis), farm incomes (vertical axis) and farm sizes (bubbles). Bubble sizes and their shifting over the plane illustrate the results for each region. In the subarctic region about 40 per cent of farms close down, whereas in the southerly regions 70-90 per cent of farms close down. An important consequence is an increase in the average size of remaining farms, sometimes a substantial one; following the exit of a large number of farms there is an increase in land available on the rental market. Farms that survive thus have the opportunity to expand by renting additional land, if it will increase their profit to do so (Box 5.3). This is boosted further by an accompanying fall in the rental price of land (Box 5.1). As such direct payments significantly slow structural change.

Looking at farm sizes in 2025 however, it is clear that not all remaining farmers choose to rent more land in the NO DIRECT PAYMENTS scenario. There are important differences in farmers' decisions between re-

gions. The findings are foremost explained by regional differences in productivity and landscape characteristics:

High-productive regions – In the high-productive intensive-cropping and mixed-farming regions, we see the largest decline in number of farms and the largest increase in sizes of the remaining farms in the absence of direct payments; the average farm is over 300 per cent larger in both regions. This is depicted in Figure 5.1, where the dark green and dark orange bubbles shift sharply to the left in the NO DIRECT PAYMENTS scenario, towards fewer farms, and become considerably larger. The effect is partly due to the relatively large number of small, part-time farms in these regions; with direct payments part-time farming and smaller farms are more viable in all regions, and when these farms quit, it is particularly visible in the high-productive regions where their numbers are higher at the outset. But the large increase in average farm sizes in NO DIRECT PAYMENTS is mainly driven by differences in soil productivity and in overall conditions for farming. The intensive-cropping and mixed-farming regions are areas consisting of a relatively large share of high-yielding land, whereas the mixed-forestry and subarctic regions are dominated by marginal land.

High-yielding land is typically used for cultivation of crops, which is an activity characterised by economies of scale, making large farms more profitable (see Box 5.3). From this follows that the profit to be made from expanding crop farms and exploiting economies of scale is high. Contributing to this are the natural landscape characteristics in the intensive-cropping and mixed-farming regions; less forest area and a flatter landscape means that agricultural land is more consolidated, fields generally larger, and the land on the market more likely to be located in close proximity to remaining farms. Hence the costs associated with expanding the farm are low. Consequently, most of the land released in these regions in NO DIRECT PAYMENTS is taken over by the surviving farms.

Low-productive regions – Similar to the high-productive regions, agricultural land is freed up in the mixed-forestry and subarctic regions in

the NO DIRECT PAYMENTS scenario. However, as can be seen in Figure 5.1 average farm sizes do not increase as dramatically; in the mixed-forestry region farms expand by about 20 per cent, and in the subarctic region farms downsize by about 10 per cent. The reason for this is the prevalence of low-yielding land and the dominance of animal production in these regions.

Cattle farms, which dominate the low-productive regions, respond differently to direct payments than crop farms. In the NO DIRECT PAYMENTS scenario, farms engaged in extensive cattle production can reduce costs while keeping production constant by using less land in production, i.e. decreasing farm size and intensifying production (Box 5.3). Output per farm is thereby maintained or even increased, but on fewer hectares of land. Additionally, because farming conditions are less favourable in these regions, geographical expansion to new fields is more costly, particularly due to small field sizes and long distances. Consequently, though land is being made available, farms cannot improve income by renting more land and hence do not grow in size. Further, without direct payments and the associated eligibility conditions, farms previously engaged in minimum agricultural activity to claim direct payments will no longer have an incentive to do so, and this land will risk being abandoned (Box 5.4).

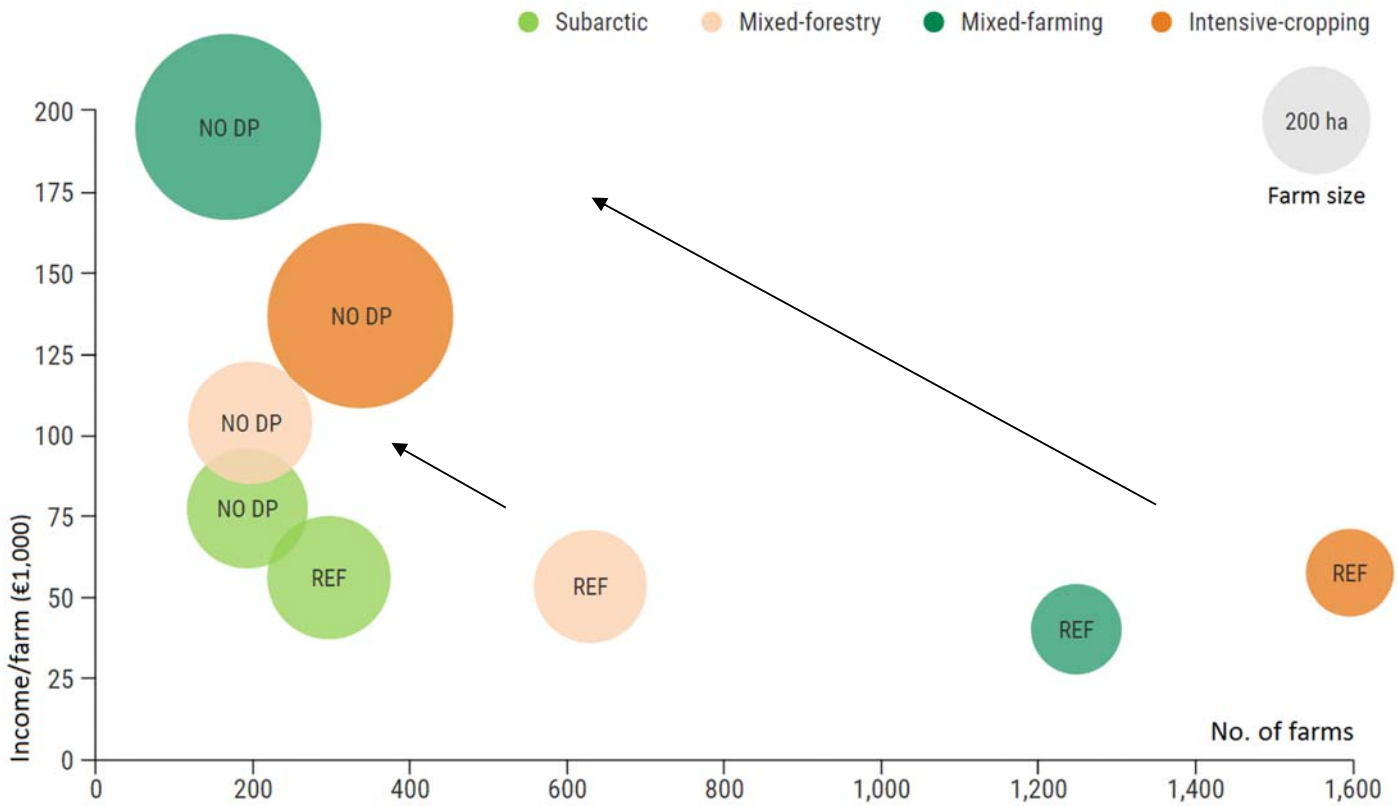


Figure 5.1 Developments in farm sizes (bubbles), number of farms and farm incomes in the REF and NO DIRECT PAYMENTS (NO DP) scenarios for each region in 2025.

Impacts on competitiveness and incomes

Without direct payments the average farm income for the remaining farms improves in all four regions. This is a result of farmers' responses to the decline in support described in Box 5.3, where the most competitive farms survive by improving productivity (options *i* or *ii*) and the less competitive farms quit (option *iii*). The increase in farm income occurs, despite the decline in the total revenues of the agricultural sector following the elimination of Pillar I direct payments and reduction in production, because the remaining farms are fewer and larger. Farm income results are depicted in Figure 5.2, where the bars show changes in income per farm and per hectare for each region as a consequence of direct payments.

Productivity – The greatest improvement in farm income in no DIRECT PAYMENTS occurs in the mixed-farming region, where farms benefit from good natural conditions and from being diversified in terms of agricultural enterprises. This is evident in Figure 5.1; the dark green bubble, representing the mixed-farming region, is located much higher on the vertical axis in the NO DIRECT PAYMENTS scenario than in the REF scenario. The mixed-farming region is also the region where the most farms close down and remaining farms grow the most in size; nearly 90 per cent of farms quit and the remaining farms grow about four times in size on average. Such a large increase in farm size opens up for improved efficiency among the remaining farms.

In the livestock dominated mixed-forestry and subarctic regions, average contribution margin per hectare increases substantially without direct payments (Figure 5.2).[28] Importantly, this increase is connected to the reduction in farm area through abandonment of the least productive land, and intensification of production on remaining farms (option *ii* in Box 5.3). In the mixed-farming region the improvement is significant but smaller, which is explained by the combination of livestock and crop farming in the region. While livestock farms, predominantly cattle farms,

[28] The contribution margin of one hectare is the amount of revenue directly attributable to the hectare, minus the cost directly attributable to the hectare. The contribution margin is the contribution each hectare makes to covering fixed costs, and thus allows a farm to evaluate the profitability of individual hectares.

shrink, crop farms expand, resulting in the average contribution margin per hectare improving moderately.

In contrast, the contribution margin per hectare declines in the crop-dominated intensive-cropping region with NO DIRECT PAYMENTS. This is explained by the average crop farm taking a different route to improving income, namely by expanding the farm area to exploit economies of scale (option *i* in Box 5.3). By renting more land, remaining farms in the intensive-cropping region achieve an improved average income (dark orange bar). The gains from exploiting economies of scale are however not sufficient to compensate for the loss of direct payments on the contribution margin per hectare in this region, which declines relative to the REF scenario (light orange bar).

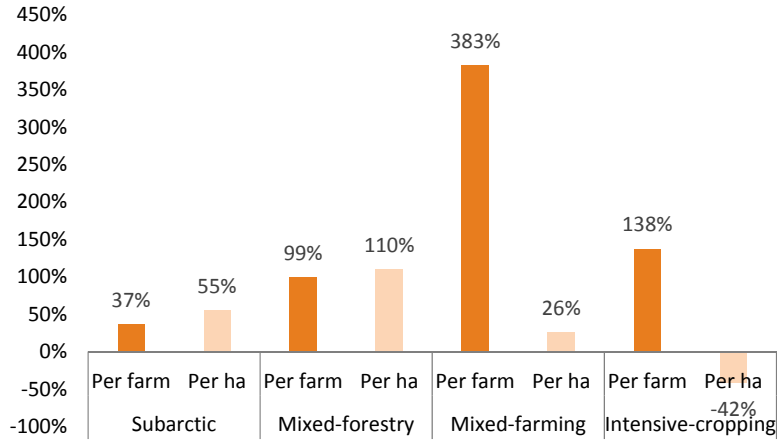


Figure 5.2 Changes in income per farm and contribution margin per hectare in the NO DIRECT PAYMENTS scenario, relative to the REF scenario, for each region in 2025.

Note: The exceptional improvements in incomes per farm, particularly in the mixed-farming region, are largely explained by farms increasing considerably in size.

Prices – A contributing factor to higher farm incomes with NO DIRECT PAYMENTS is the increase in prices of agricultural products that results from the associated output reductions (Box 5.2). The CAPRI simulations

indicate that NO DIRECT PAYMENTS leads to a rise in world market prices for all agricultural products, and the improvement is particularly large for beef.[29] Thus the remaining beef farmers in this scenario not only improve their incomes by becoming more productive, but also receive a higher price for their output than in the REF scenario.

Thus the faster structural change, improved productivity and higher output prices combine in the NO DIRECT PAYMENTS scenario to improve farm incomes in all regions. The largest increase in average income per farm takes place in the mixed-farming region, where it grows nearly fourfold (dark orange bars in Figure 5.2). Income per farm increases considerably also in the intensive-cropping and mixed-forestry regions, but relatively modestly in the subarctic region. This is because the number of farms and average farm size change comparatively little in the subarctic region, owing to the remaining ANC and Nordic Aid support, which hold back structural development. Recall that we are not referring to the incomes of a fixed number of farms, but to rising incomes for a decreasing number of farms that become substantially larger. Consequently, the negative impacts of direct payments on structural change, productivity and output prices result in lower average farm incomes.

Impacts on land use

Pillar I direct payments avoid substantial abandonment of agricultural land in the mixed-farming, mixed-forestry and subarctic regions. This is because abandonment in NO DIRECT PAYMENTS predominantly affects low-yielding land that is not profitable enough to be taken over by remaining farms. This is shown in Figure 5.3 where the bars show the areas of different land uses as proportions of the total agricultural land area for each scenario and region. By comparison with the REF scenario we can see which regions and land uses that are more sensitive to the direct payments and which are more stable. Generally, it is fallow land and extensive forms of land use that decline (i.e. extensive grass and

[29] Price changes are imported into AgriPoliS from CAPRI, since AgriPoliS, being a regional model, cannot predict changes in world market prices.

semi-natural pasture) without direct payments, which are primarily found in the more marginal regions.

The largest impacts of direct payments occur in the mixed-forestry region; without them over 70 per cent of semi-natural pasture and 60 per cent of arable land is abandoned. This land will eventually become forest, either through natural regeneration or planting. Land abandonment in the subarctic region is less dramatic, owing to the subarctic region benefitting from higher ANC-payments and Nordic Aid (Table 5.2). Due to the importance of livestock in the subarctic region and agri-environment payments for semi-natural pasture under Pillar II, the relatively small area of pasture is not affected by NO DIRECT PAYMENTS (dark green section). Thus direct payments are contributing to maintaining extensive agriculture, whereas intensive agriculture – particularly arable crops – is largely unaffected in our study regions. Further, the impacts of direct payments are moderated by the extent of Pillar II schemes.

A significant amount of land, 42 per cent, is also abandoned in the mixed-farming region with NO DIRECT PAYMENTS. The affected areas are low-yielding arable land and semi-natural pasture. Abandonment in the intensive-cropping region is limited; about 8 per cent of the total agricultural area is abandoned and overgrown, primarily previously fallowed land.

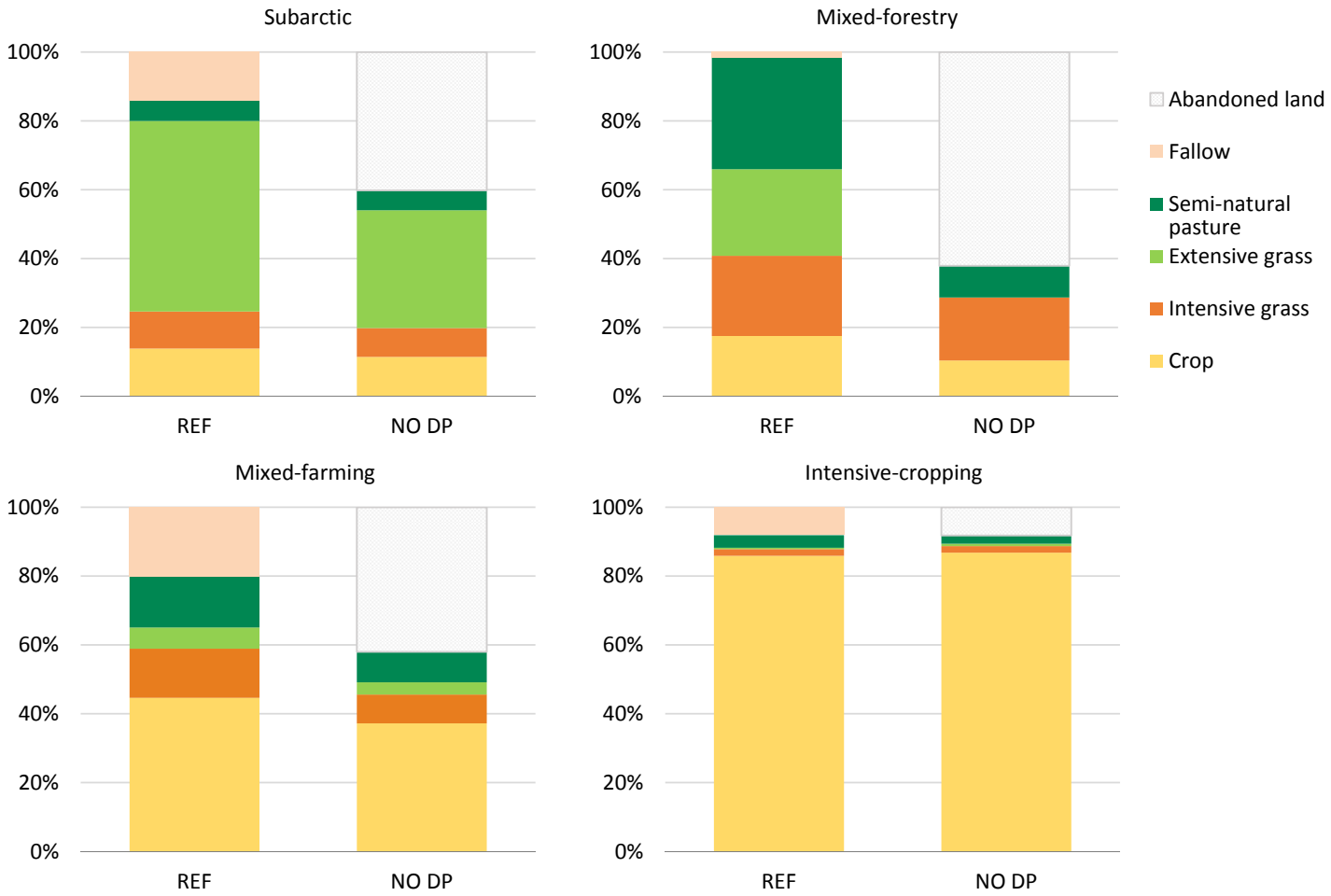


Figure 5.3 Simulated agricultural land use in the REF and NO DIRECT PAYMENTS (NO DP) scenarios for each region in 2025, as a proportion of the total agricultural area in the region.

Land abandonment has two major causes. First, in the NO DIRECT PAYMENTS scenario, the conserving function of the minimum activity requirement will also disappear, that is, the incentive to continue to manage marginal land (Box 5.4). A direct consequence of this is that fallow land disappears entirely in all regions without direct payments. The second cause is connected to the productivity of land, translated into profits; without the direct payment for land, some hectares may not provide sufficient contribution margin to make farming them worthwhile (Box 5.3). Both mechanisms are of particular importance to marginal land or land that is geographically inaccessible, because such land yields less output and adds disproportionally to costs. Less land is abandoned and overgrown in the intensive-cropping region because land is on average of better quality and geographically concentrated, making it worthwhile to farm even without direct payments.

Impacts on production

The largest production effects of direct payments occur in the livestock enterprises, including greater production of crops intended for animal feed. Another important impact is the extensification of farming, an issue that has been touched upon previously in this chapter, but that deserves particular mention. Two forces drive intensification in NO DIRECT PAYMENTS the case of Sweden; a higher relative cost of using land as an input in production (i.e. direct payments reduce the cost of using land), and higher crop prices on the world market that increase the optimal input rates of fertilisers and pesticides.

Low-productive regions – Beef production is substantially higher in the livestock-dominated subarctic and mixed-forestry regions as a result of direct payments. Figure 5.4 compares the distribution of different types of livestock emerging in the REF and NO DIRECT PAYMENTS scenarios in 2025, as proportions of total livestock units in REF in 2025. Our simulations show that suckler cows, the extensive rearing of beef animals, disappear entirely in the mixed-forestry region, and beef cattle production is reduced in both regions in NO DIRECT PAYMENTS. The remaining beef production is intensified, which typically involves a shift from

rearing animals on pasture to raising them in confinement. This saves costs of renting land and transporting animals, and is generally accompanied by more intensive feeding practises, i.e. using silage, grains and concentrates rather than pasture. Dairying is less sensitive to direct payments owing to higher profit margins and being reliant on intensive farming practices.

These impacts on livestock are associated with impacts on extensive grass production and pastures; 60 per cent of agricultural land in the mixed-forestry region is used for extensive production of feed in the REF scenario. This declines to 10 per cent of the original area in the NO DIRECT PAYMENTS scenario (Figure 5.3). For similar reasons the decline is also substantial in the subarctic region. This indicates that direct payments in Sweden particularly favour land-intensive (extensive) farming.

High-productive regions – The principal production impacts in the high-productive regions also occur in the livestock enterprises. The most striking effect of NO DIRECT PAYMENTS is a large increase in pig production in both regions, linked to the low land requirement in the industry (Figure 5.4). Dairying also increases in the intensive-cropping region, whereas beef production is reduced in the mixed-farming region. These results again point to a generally more extensive livestock production with direct payments.

The production of cash crops such as wheat and oilseed rape is less affected by direct payments; contribution margins per hectare in cash crops are generally higher than in livestock production, hence direct payments are relatively less important in these enterprises.

Similar to livestock production however, there is an intensification in cash crop production with NO DIRECT PAYMENTS in response to the associated increase in world market prices. Higher prices encourages higher use of pesticides and fertilisers per hectare.

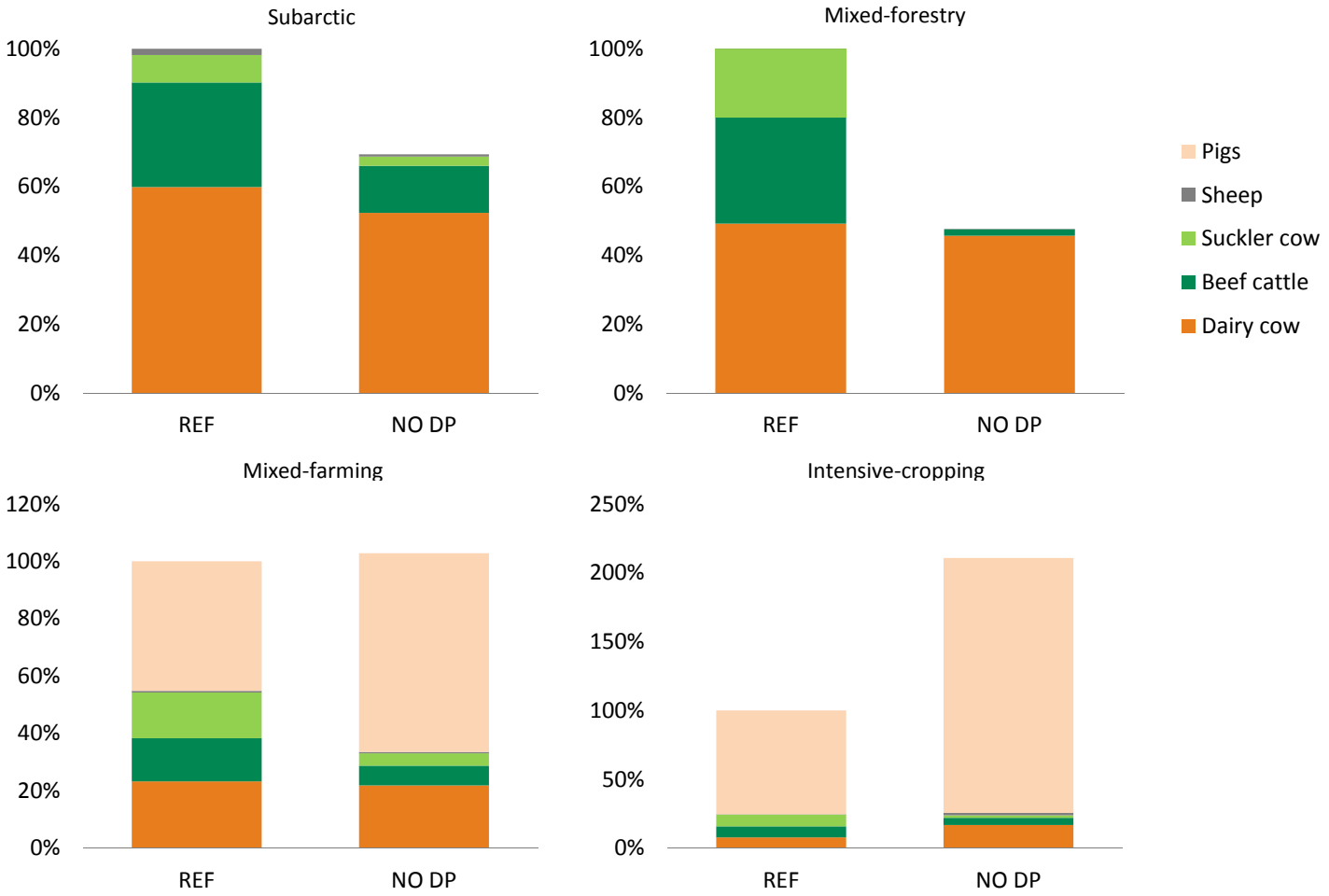


Figure 5.4 Livestock distribution in the REF and the NO DIRECT PAYMENTS (NO DP) scenarios in livestock units, relative to the total number of livestock units in the REF scenario in 2025.

Note: Heads are expressed as livestock units to make comparison across enterprises possible: dairy cow = 1.0, beef cattle= 0.4-0.6, suckler cow = 0.6-0.8, sheep = 0.1 and pigs = 0.3-0.5.

Sheep production increases somewhat in NO DIRECT PAYMENTS as a share of total livestock production in the intensive-cropping region, albeit from low levels. Prior to 2015 sheep production was on the rise in all regions, but was crowded out by cattle production due to the introduction of the Voluntary Coupled Support to cattle. When the coupled support is eliminated, this crowding-out effect disappears. In the mixed-farming region however, as well as in the subarctic where sheep production was more important in 2020, the enterprise shrinks the in NO DIRECT PAYMENTS scenario. This and other results from this section suggest that even though direct payments are decoupled from production, they have substantial indirect impacts on production and land use (Box 5.5).

Impacts on polluting emissions

On the whole, the higher agricultural production resulting from direct payments leads to higher nutrient surpluses, greenhouse gas emissions (GHG) and use of pesticides. Most of these negative impacts on the environment are associated with the higher levels of livestock production. However, the lower output prices that accompany the higher EU production, result in less intensive farming, which in some instances counteract the negative environmental effects.

Nutrient surplus – Total nitrogen surpluses decline everywhere but in the intensive-cropping region in NO DIRECT PAYMENTS. The increase in the intensive-cropping region is linked to the increase in pig and dairy production (Figure 5.4), and to intensification of cash crop production. The growth in purchases and production of feed for the additional animals are followed by an inflow of both nitrogen and phosphorus. Some of the nutrients leave the farm in the final products, pork and milk, but large quantities remain on the farm in manure. Manure to some extent in this case replaces mineral fertiliser purchases, which explains the decline in phosphorus surplus. The increase in nitrogen surplus is instead explained by the intensification of cash crop production; the increase in world market prices of agricultural products raises the optimal dose of fertiliser per hectare by an average of 10 per cent (since fertiliser prices are assumed constant). Because the area of cash crop production is unaf-

fected by NO DIRECT PAYMENTS (Figure 5.3), this causes an increase in total surplus.

The most substantial decline in nutrient surplus in absolute terms occurs in the mixed-farming region, again as a result of changes in livestock production; a reduction in ruminants such as beef and dairying, and an increase in pig production. The feed for the new livestock composition involves less feed production on the farms, particularly of silage and coarse grains, and more feed purchased on the market. The new practise requires lower fertiliser inputs and results in a lower surplus of both nitrogen and phosphorus. This occurs despite the intensification of cash crop production, where fertiliser inputs per tonne of output increases on average by 15 per cent.

In the mixed-forestry and subarctic regions there is a decline in nutrient surplus that is also attributable to a reduction in livestock, with accompanying decline in feed requirement. There is an increase in phosphorus surplus in the mixed-forestry region as the remaining animals are fed with grains instead of grass, but from a very low level.

Whereas total nutrient surpluses decline in most regions with NO DIRECT PAYMENTS, changes in nutrient surplus *per hectare* are less positive, echoing the production changes and the intensification of farming. Figure 5.5 shows the differences in absolute terms between the average nutrient surplus, or deficit, per hectare of arable land. It displays both the difference between the scenarios and illustrates the differences between the low- and high-productive regions. Our results show that there is an increase in per-hectare nitrogen surplus in the intensive-cropping region in the NO DIRECT PAYMENTS scenario of 12 per cent, compared to the REF. This follows from the intensification in cash crop production and the expansion of intensive livestock production. In the other three regions the decline in feed production results in lower nitrogen surpluses per hectare. Phosphorus surplus per hectare increases in the low-productive regions, again owing to intensive feed production replacing grass.

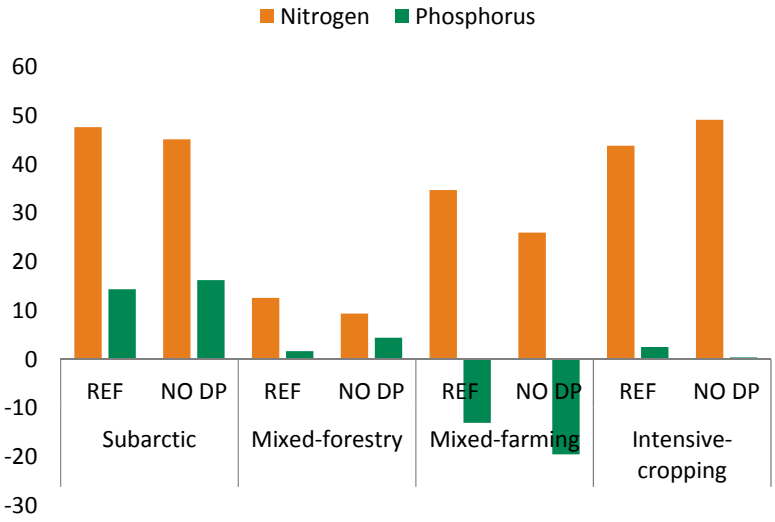


Figure 5.5 Nutrient surplus per hectare arable land (kilogram) in the REF and the NO DIRECT PAYMENTS (NO DP) scenarios, for each region in 2025.

Greenhouse gas emissions – Agriculture contributes to climate change through the emission of greenhouse gases (GHG). Ruminants are important emitters. In the REF scenario, emissions of greenhouse gases per hectare are largest in the mixed-forestry region, at 4.3 tonnes carbon dioxide equivalents (CO2eq) per hectare, followed by the subarctic (3.3 CO2eq/ha) and mixed-farming (2.5 CO2eq/ha) regions. Due to the relatively small number of livestock in the intensive-cropping region, GHG emissions per hectare for the region are far below those in the other three regions in all scenarios; GHG emissions in the REF scenario are 1.2 CO2eq per hectare.

As a result of the decrease in livestock production, emissions of GHG are reduced in the subarctic, mixed-forestry and mixed-farming regions in the NO DIRECT PAYMENTS scenario. Figure 5.6 illustrates changes in emissions of greenhouse gases in livestock production, and to which enterprise the change is attributable. An increase in emissions is shown as a

positive change and a reduction as a negative. The net effect on emissions are shown as labels. The largest reduction takes place in the mixed-forestry region where emissions from livestock production are reduced by 44 per cent, predominantly owing to a decline in beef production and in the number of suckler cows (Figure 5.6). These two traditionally extensive enterprises that are disproportionally affected by the pressure to intensify production, are the principal explanations for reductions in GHG emissions also in the subarctic and mixed-farming regions. In contrast, GHG emissions increase in the intensive-cropping region. Most GHG emissions here come from crop production rather livestock, resulting in an 8 per cent increase in total GHG emissions in the region. This increase in emissions is mainly due to the expansion of dairying in the region, resulting in a 25 per cent increase in emissions from livestock production. Consequently, direct payments are generally augmenting greenhouse-gas emissions.

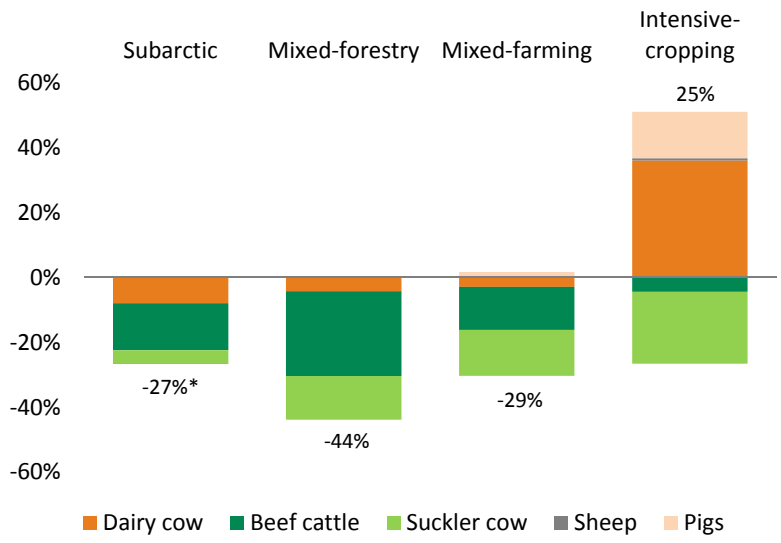


Figure 5.6 Net changes in greenhouse gas emissions for livestock production per livestock enterprise in the NO DIRECT PAYMENTS scenario compared to the REF scenario, for each region in 2025.

** Percentage labels indicate net effects on emissions.*

Pesticides – When total agricultural production declines in NO DIRECT PAYMENTS, the total application of fungicides, insecticides and herbicides also decreases. The largest relative decline takes place in the low-productive regions, particularly in herbicides for which application is roughly halved. Crop production is limited in these livestock-dominated regions and hence the decline in pesticide use occurs from already very low levels. Total use declines also in the mixed-farming region, which in absolute terms is more substantial because crop production in the mixed-farming region is more prevalent as well as more intensive, and thus application is higher at the outset. In contrast, because crop production in the intensive-cropping region declines only marginally with NO DIRECT PAYMENTS, application of pesticides is only marginally reduced. This indicates that direct payments are exacerbating pollution problems in intensively farmed regions.

Conversely, similar to the effects on nutrient surplus, average application of pesticides *per hectare* increase everywhere but in the subarctic region in NO DIRECT PAYMENTS. The most notable change occurs in the mixed-farming region, where fungicide application rate increases by 50 per cent. This follows from intensification of production (growing more feed grain) on the remaining hectares, as fungal disease constitutes a larger threat to crop production when there is less extensive grass in the crop rotation. The increase in per-hectare use of pesticides is not as strong in the intensive-cropping region, which is a consequence of more land remaining in production and higher application rates to begin with. The decline in application rates of herbicides in the subarctic region follows from reduced crop production, for which the application rate is higher than for the average hectare in the region.

The finding of an increase in average application rates in NO DIRECT PAYMENTS while total use declines, indicates that local effects on pollution from chemicals and other variable inputs may be different from what the overall results show, that is to say, a spatial variation in effects.

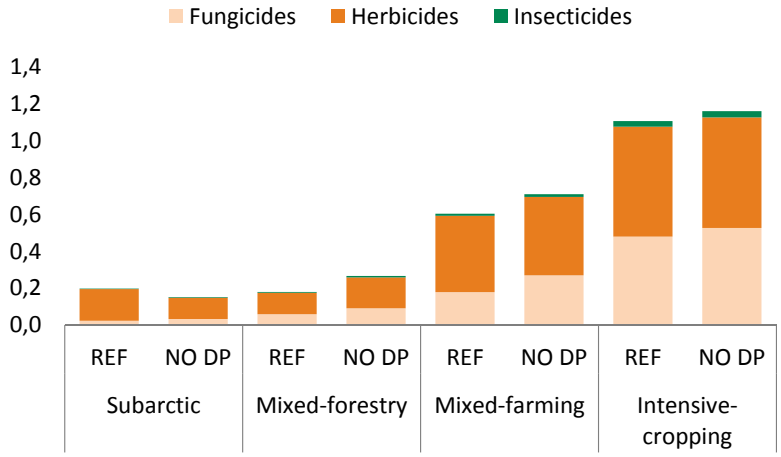


Figure 5.7 Application of pesticides (active dose in kilogram per hectare) in the REF and NO DIRECT PAYMENTS (NO DP) scenarios, for each region in 2025.

Impacts on biodiversity

The NO DIRECT PAYMENTS scenario has negative impacts on biodiversity due to substantial amounts of agricultural land being abandoned and overgrown in all regions (Figure 5.3). The deterioration is mainly driven by the reduction in semi-natural pasture and intensification of animal husbandry discussed previously in this chapter. Semi-natural pasture is high nature value (HNV) farmland with higher plant diversity and a larger fauna than arable land. Because HNV farmland is used in extensive production it is particularly affected by direct payments linked to land.

The mixed-forestry and mixed-farming regions are areas of particular importance for biodiversity, owing to the large amounts of semi-natural pasture and extensive grass land in these regions, compared to the subarctic and intensive-cropping regions. Figure 5.8 shows effects on biodiversity in the NO DIRECT PAYMENTS scenario, and indicates to which land use change the decline is attributable. In the REF scenario one third

of the total agricultural area in the mixed-forestry region consists of semi-natural pasture and 15 per cent in the mixed-farming regions (Figure 5.3). This can be compared with 4 per cent and 6 per cent in the intensive-cropping and subarctic regions, respectively. In the NO DIRECT PAYMENTS scenario, the area of semi-natural pasture declines by over 70 per cent in the mixed-forestry region, and also declines as a share of the total agricultural area in the region. In the mixed-farming region semi-natural pasture declines by 40 per cent. As a consequence, deterioration of biodiversity is strongest in the mixed-forestry region, at about 23 per cent, and at about 11 per cent in the mixed-farming region (Figure 5.8).

Intensification in the intensive-cropping region in NO DIRECT PAYMENTS is in all likelihood also going to affect biodiversity. Increased use of pesticides and fertilisers in this region, which is already dominated by high application rates, is harmful for the flora and fauna that remains, as is homogenisation of the agricultural landscape; the NO DIRECT PAYMENTS scenario also results in a substantial decline in landscape variation in the region. Our biodiversity indicator is however, being based on inventories of red-listed species, not appropriate for analysing the intensive-cropping region, because we do not have evidence that intensive arable cropping is today supporting threatened species. Rather, the intensive-cropping region represents a more general threat to biodiversity in other ecosystems such as unfarmed areas and the Baltic Sea. Consequently it is excluded from this part of the analysis.

Our results indicate that direct payments are supporting biodiversity conservation, but principally in marginal regions. In the next section we present results from the PUBLIC GOODS scenario, where we introduce an instrument to prevent abandonment of marginal agricultural land.

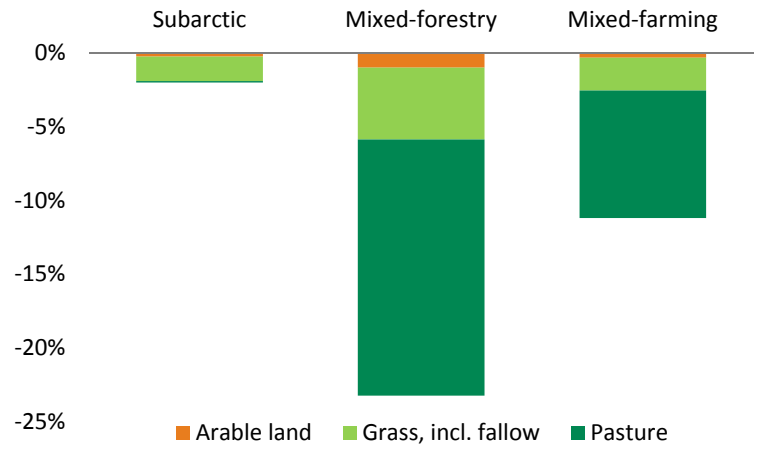


Figure 5.8 Decline in biodiversity in the NO DIRECT PAYMENTS scenario compared to the REF scenario, and the share of the decline that is attributed to each land use.

Note: Because there are no red-listed species dependent on agricultural land in the intensive-cropping region, this region is excluded from the biodiversity analysis.

5.4 PUBLIC GOODS scenario – replacing Pillar I direct payments with targeted payments for marginal land

The analysis of the impacts of direct payments in the previous section and in chapter 4 show that although these promote small-scale and low-income agricultural production, they also contribute to preserving substantial areas of marginal agricultural land that is important for preserving environmental quality and food security. This is not least applicable in Sweden, where a large share of the total agricultural area is marginal land. This serious goal conflict for Pillar I direct payments arises from their general nature; a universal payment to all agricultural land and hence all farmers. There are however alternative policy instruments with the potential to avoid such goal conflicts. We have chosen to demonstrate the application of the Provider Gets Principle in an instrument intended to finance the provisioning of public goods from marginal land, public goods that would be lost if this land were abandoned.

In this section we present results from the simulations of the PUBLIC GOODS scenario, in which farms receive a per-hectare payment for the

marginal land on their holdings (see Box 3.1). The payment is conditional on maintenance of the marginal land, with management requirements similar to the Basic Provisions in Regulation 1307/2013. The purpose of the payment is to compensate farmers for provisioning of public goods, and thus an application of the Provider Gets Principle discussed in Box 2.5.

Changes in agricultural support in Sweden

The payment for marginal land is similar to the sum of the basic and Greening Payment in the REF scenario, plus the 13 per cent of the Pillar I budget used to finance the Voluntary Coupled Support to cattle (Table 5.3). In terms of eligibility, the PUBLIC GOODS scenario means that farms with only marginal land on their holdings will receive an amount similar to the support they received in 2020, which avoids confounding the results by introducing changes in the level of support in addition to the grounds for receiving support, which is our focus. For farms without any marginal land on their holding the situations under the PUBLIC GOODS scenario is identical to the NO DIRECT PAYMENTS scenario; they no longer receive any payments. From this follows that farms in the subarctic and mixed-forestry regions are eligible for the public-goods payment for all of their land, while in the mixed-farming region about 50 per cent of land is eligible, and in the intensive-cropping region, where marginal land is uncommon, only 13 per cent.

Impacts on land use

There is virtually no increase in land abandonment in the PUBLIC GOODS scenario, compared to the REF scenario. This result is in strong contrast to the NO DIRECT PAYMENTS scenario, where a considerable amount of land is abandoned in all regions. In contrast, in the PUBLIC GOODS scenario all of the land that is farmed in the REF scenario remains in agricultural management (Figure 5.9). This shows two things. First, in the marginal areas where market returns are insufficient to cover the opportunity costs of farming, the public-goods payment together with an accompanying activity obligation prevents land abandonment. Second, in productive areas, the market return is sufficient to motivate

agricultural production and hence no land abandonment occurs despite the absence of direct payments.

Table 5.3 Annual Pillar I direct payments in AgriPoliS, in 2025 in the REF scenario and the PUBLIC GOODS (PG) scenario for each region.

	Subarctic		*Mixed-forestry*		*Mixed-farming*		*Intensive-cropping*	
Scenario	REF	PG	REF	PG	REF	PG	REF	PG
Public-goods payment (per ha of marginal land)	-	€223	-	€223	-	€223	-	€223
Basic Payment	€135	-	€135	-	€135	-	€135	-
Greening Payment	€58	-	€58	-	€58	-	€58	-
VCS to cattle (per animal older than 1 year)	€91	-	€91	-	€91	-	€91	-
LFA payments*	€115 to €231	€115 to €231	€52 to €105	€52 to €105	-	-	-	-
Milk support (per dairy cow)	€701	€701	-	-	-	-	-	-

* The upper bound is the amount given to grassland not exceeding 200 ha/farm (for grassland types 1-3) and not exceeding 70 ha/farm (for type 4 and arable land).

Furthermore, Figure 5.9 shows that the differences in land use between the REF and the PUBLIC GOODS scenarios in all four regions are small, indicating that production changes little also on the land that is not eligible for the public-goods payment. One large difference though is a 30 per cent increase in the area of grain production used for feeding livestock in the mixed-farming region, and a corresponding reduction in fallow land. This is a result of the increase in the world market output prices, predominantly of livestock products, brought about by the aggregate decline in European production in the PUBLIC GOODS scenario (see

Box 5.2). The price increases are however not sufficient to induce greater production in the most marginal subarctic and mixed-forest regions where land is maintained in fallow, or in the intensive-cropping region.

Impacts on agricultural structure, competitiveness and incomes

Farms in the mixed-farming and intensive-cropping regions experience the largest reduction in support in the PUBLIC GOODS scenario, owing to the relatively low eligibility for the public-goods payment in the regions. The consequence is that 80-90 per cent of farms quit, which is similar to the results from the NO DIRECT PAYMENTS scenario. Figure 5.10 shows this development; the dark green and dark orange bubbles shift far left in both scenarios. In the intensive-cropping region average farm size also increases to about the same size as in the NO DIRECT PAYMENTS scenario, whereas in the mixed-farming region farms grow substantially more. This follows from the land use results that were described previously; as a consequence of the public-goods payment, no agricultural land is abandoned and the remaining farms take over all the land released by the quitting farms. Farms in the intensive-cropping do not grow much more than in the NO DIRECT PAYMENTS scenario, because the released land is high-yielding and therefore taken over by remaining farms even without the incentive of the public-goods payment.

Due to the elimination of payments to high-yielding land, and because no land is abandoned, the average contribution margin *per hectare* declines in the high-productive regions. Nevertheless, income *per farm* increases, both in comparison to the REF and the NO DIRECT PAYMENTS scenarios, owing to the large increase in farm size; larger farms naturally have a larger income, but are also able to exploit scale economies to reduce costs. The income improvement is larger in the mixed-farming region, owing to the emergent larger average farm size. Our results thus indicate that agriculture in the high-productive regions is not dependent on supporting payments; rather abolishing payments improves productivity, competitiveness and income in the regions.

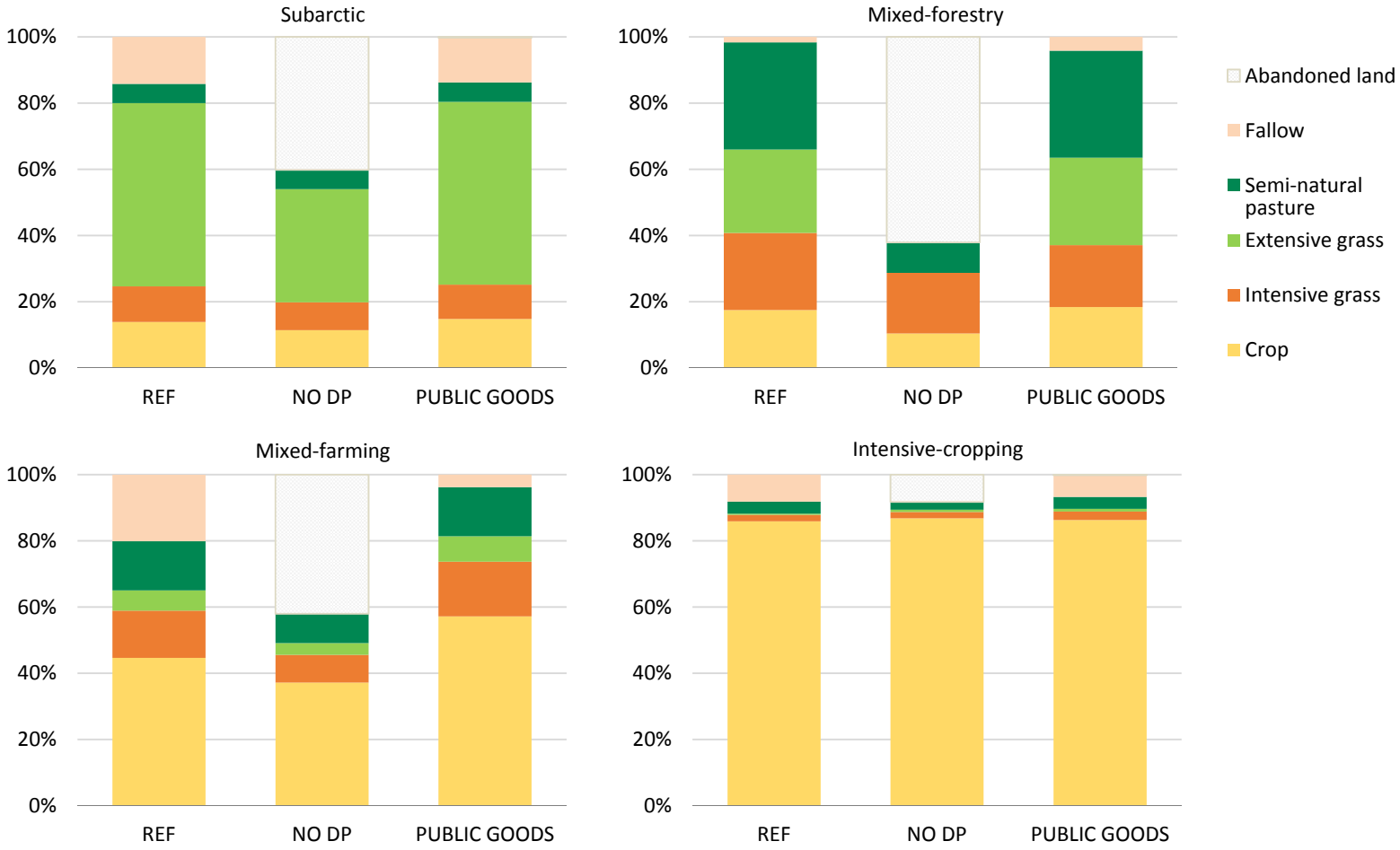


Figure 5.9 Distribution of agricultural land uses in the REF, NO DIRECT PAYMENTS (NO DP) and PUBLIC GOODS scenarios, for each region in 2025.

As the subarctic and mixed-forestry regions are comprised entirely of marginal land, the public-goods payment applies to all land. Hence, many of the structural consequences of NO DIRECT PAYMENTS discussed in section 5.3 are avoided with the public-goods payment. For instance, only 10 per cent of farms in the mixed-forestry region quit, in the PUBLIC GOODS scenario (Figure 5.10). This can be compared to the 70 per cent that quit in the NO DIRECT PAYMENTS scenario. That some farms quit in the low-productive regions even though all farmland is eligible for the public-good payment is because the coupled support to cattle is also eliminated; even though farms continue to receive a payment per hectare, those that previously benefitted from large additional cattle support will receive a smaller amount after 2020. In the subarctic region only 3 per cent of farms quit, compared to 35 per cent in the NO DIRECT PAYMENTS scenario. Again, more farms remain in the subarctic than in the mixed-forestry region thanks to the considerable support provided under the Nordic Aid Scheme and in ANCs payments in the region.

Farm income improves in the mixed-forestry region compared to the REF scenario, though somewhat less than in the NO DIRECT PAYMENTS scenario, whereas income declines in the subarctic. That incomes increase less or even decline in the PUBLIC GOODS scenario despite all hectares being eligible for payments may seem a surprising result. Primarily it is due to the direct and indirect consequences of price increases, which are lower than in the NO DIRECT PAYMENTS scenario. The influence of the Nordic Aid Scheme and ANCs payments is also important, as these hold up farm incomes even without direct payments. Together, these results demonstrate that a payment to marginal land leads to preservation of agricultural activity in low-productive regions and without major negative impacts on productivity, since these regions have limited scope to improve productivity through scale increases.

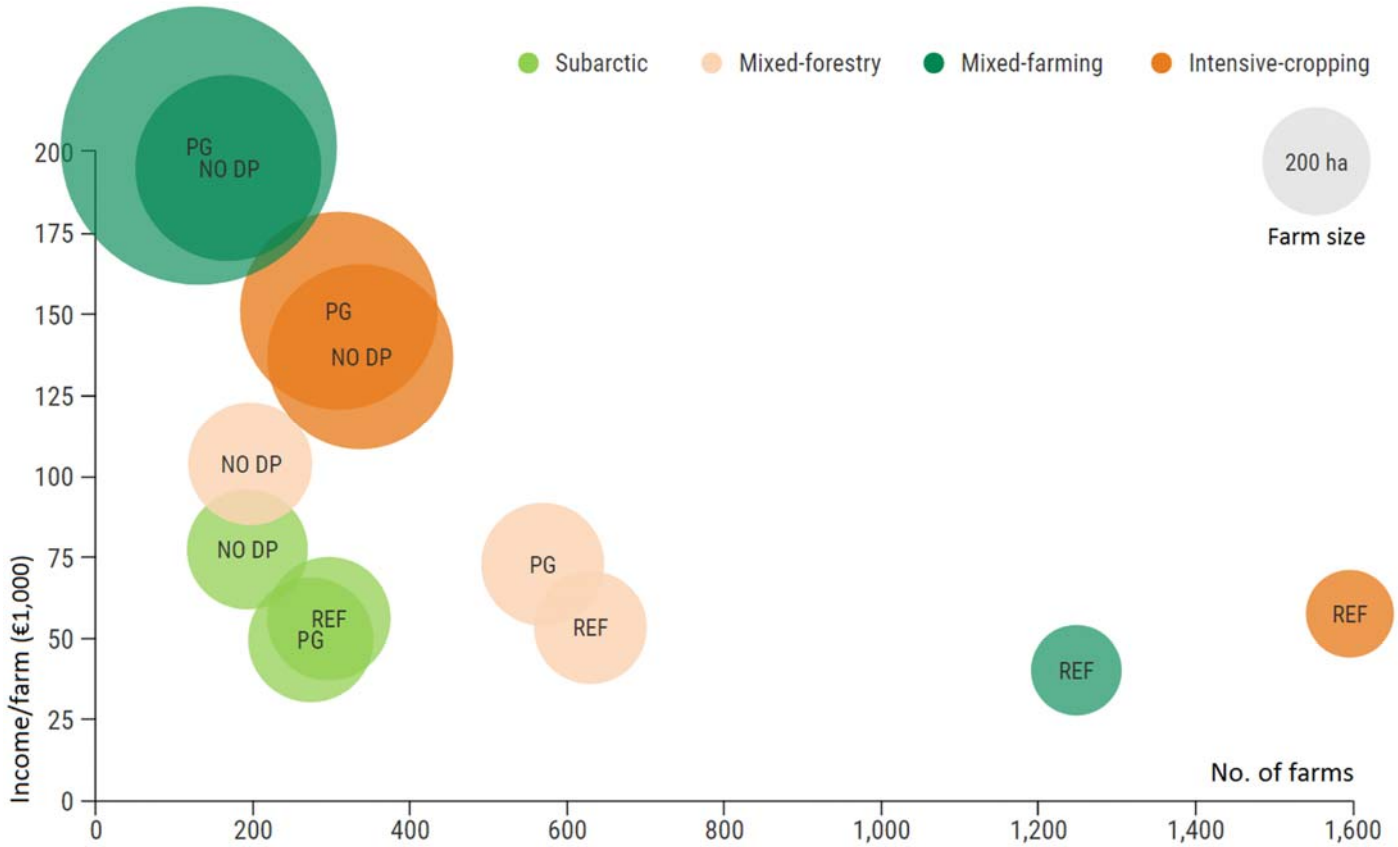


Figure 5.10 Comparison of developments in average farm sizes (bubbles), number of farms and average farm incomes in the REF, NO DIRECT PAYMENTS (NO DP) and PUBLIC GOODS (PG) scenarios in 2025.

Impacts on livestock production

Livestock holdings, particularly beef cattle and suckler cows, are sensitive to direct payments; this is mitigated by the public-goods payment. In particular, the payment provides farms in the low-productive regions with an incentive to continue extensive production on marginal land (the mechanism is described in Box 5.4). Figure 5.11 shows how livestock production per enterprise changes in the PUBLIC GOODS scenario, compared to the production in the REF and NO DIRECT PAYMENTS scenarios; there are small declines in suckler and beef cattle production in the PUBLIC GOODS scenario compared to the REF (left columns), but there is an increase compared to the NO DIRECT PAYMENTS scenario (right columns). The small reduction in cattle in the PUBLIC GOODS scenario results from the elimination of the coupled support to cattle (Table 5.3). Further, the potential negative impacts on livestock production are somewhat counteracted by an increase in the world market prices of meat and milk (Box 5.2).

In contrast, livestock production increases in the high-productive regions in the PUBLIC GOODS scenario, both compared to the REF scenario and the NO DIRECT PAYMENTS scenario (bottom panels). The increase takes place primarily in the intensive pig-fattening industry, which requires comparatively little own land for fodder production. The expansion in intensive livestock production is larger than in the NO DIRECT PAYMENTS scenario, due mainly to a higher price of pork.

Figure 5.11 Relative changes in livestock units in the PUBLIC GOODS (PG) scenario in each region compared to the total number of livestock units in the REF (PG – REF) and NO DIRECT PAYMENTS (PG – NO DP) scenarios, in 2025.

Note: Livestock holdings are expressed as livestock units (LU) to make comparison across enterprises possible, where a dairy cow = 1.0 LU, and, beef cattle= 0.4-0.6, suckler cow = 0.6-0.8, sheep = 0.1 and pigs = 0.3-0.5 LU.

Impacts on polluting emissions

As expected, the PUBLIC GOODS scenario shows ambiguous results for polluting emissions (Figure 5.12 and Figure 5.13); the payment is not targeted on preventing pollution but on maintaining land, which can indirectly support production and hence have negative environmental impacts. Emissions are also influenced by a change in production in response to increases in world market prices. Consequently, a payment for public goods cannot be expected to resolve pollution problems; rather a separate policy instrument is needed.

Nutrient surplus – In the PUBLIC GOODS scenario total surplus of nitrogen increases in the high-productive regions, both compared to the REF and the NO DIRECT PAYMENTS scenarios. The largest increase occurs in the mixed-farming region as a consequence of previously fallowed land being put into barley production for feed, thus increasing use of fertilisers. The same takes place in the intensive-cropping regions, but to a smaller extent. In contrast, nitrogen surplus is unchanged in the subarctic region and becomes a deficit in the mixed-forestry region; that is to say, more nutrients are being exported from farms than are being imported in inputs.

Phosphorus surplus is reduced everywhere. In the low-productive region this is a consequence of the decline in cattle production and feed purchases. In the high-productive region the reason is the opposite; an increase in dairying and pig production causes both direct phosphorus extraction from the soil, and indirect reduction in inputs as manure replaces mineral fertilisers in crop production.

Figure 5.12 shows how the absolute values of nutrient surpluses *per hectare* change in the PUBLIC GOODS scenario. In general, compared to the REF scenario (PG – REF), the surpluses per hectare remain constant or decline. The exception is the intensive-cropping region, where nitrogen surplus per hectare increases by 15 per cent (orange bar). Again, this is a consequence of the increase in feed production and purchases in the growing intensive livestock enterprises, as well as an intensification in cash crop production, in response to higher output prices.

In the mixed-farming region average nitrogen surplus per hectare is virtually unchanged, despite the increase in the total surplus. This is because the increase in barley production occurs on land that was previously fallowed, i.e. on land where fertilisers were previously not applied.

In the mixed-forestry region, which receives a great deal of public-goods payments, nitrogen surplus per hectare declines drastically, compared both to the REF scenario and to the NO DIRECT PAYMENTS scenario. This is linked to the decline in cattle and feed production due to eliminating the Voluntary Coupled Support to cattle, but occurs from already low levels.

An important thing to note regarding these results is that the public-goods payment does not *cause* the increase in nutrient surplus in high-productive regions. It is a result of higher prices following the abolishment of direct payments; the larger the increase in output prices, the higher is the optimal nutrient dose and, consequently, use of fertilisers. The public-goods payment is targeting preservation of marginal land and can thus not be expected to have positive effects on nutrient balances on intensively farmed land. Problems with nutrient surpluses need to be addressed with appropriate instruments, such as the tax on fertilisers analysed with the CAPRI model in section 4.4.

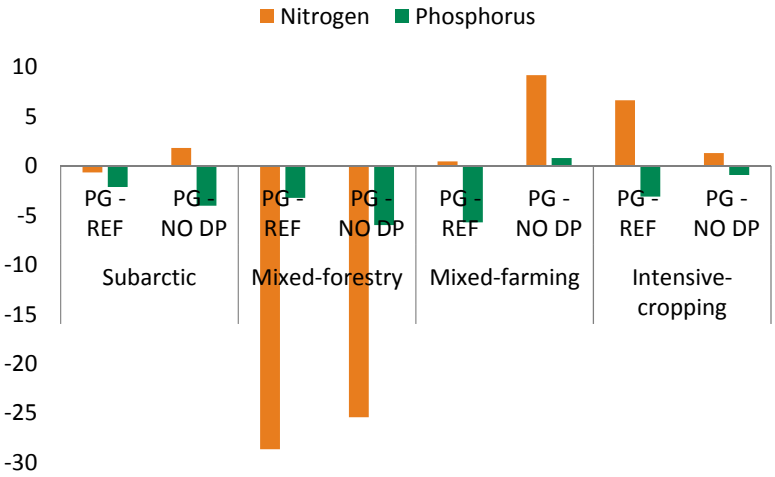


Figure 5.12 Absolute changes in nutrient surpluses per hectare (kg) in the PUBLIC GOODS scenario compared to the REF (PG – REF) and NO DIRECT PAYMENTS (PG – NO DP) scenarios, in 2025.

Note: The surplus is combined across agricultural enterprises (i.e. farm-gate surplus).

Greenhouse gas emissions – Compared to the REF scenario, total GHG emissions in the high-productive regions increase by 26 and 14 per cent in the PUBLIC GOODS scenario in the mixed-farming and intensive-cropping regions, respectively. The increase is almost exclusively a consequence of the increase in livestock production, in particular to the growth of the dairying enterprise. This is shown in Figure 5.13, which displays the changes in GHG emissions from livestock production in the PUBLIC GOODS scenario, relative to the REF and NO DIRECT PAYMENTS scenarios. In the mixed-forestry and subarctic regions, GHG emissions in livestock production are reduced by 9 and 5 per cent compared to the REF scenario, respectively. There is, conversely, an increase in emissions compared to the NO DIRECT PAYMENTS scenario, because the reduction in livestock production is not as large in the PUBLIC GOODS scenario (compare Figure 5.6 and Figure 5.13). Consequently, mitigation of greenhouse gas emissions also requires a targeted policy.

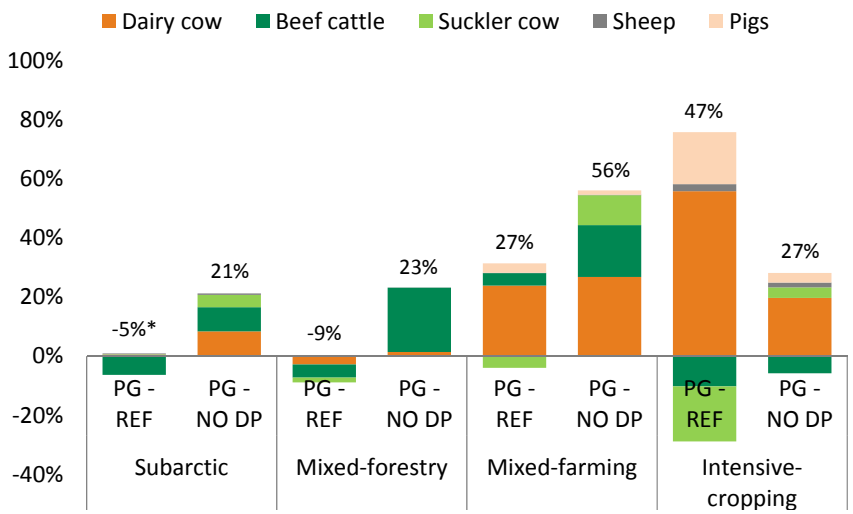


Figure 5.13 Relative changes in annual greenhouse gas emissions from livestock production in the PUBLIC GOODS scenario compared to the REF (PG – REF) and NO DIRECT PAYMENTS (PG – NO DP) scenarios, in 2025.

** Percentage labels indicate net effects on GHG emissions in livestock production.*

Pesticides – The most notable effects on the use of pesticides in the PUBLIC GOODS scenario occur in the mixed-farming region, where application of fungicides and insecticides increase by 24 per cent and 40 per cent respectively, following the transformation of fallow land into crop fields, and an increase in the optimal dose of pesticides generally in response to the increase in prices of agricultural goods. In the low-productive regions the use of pesticides also increases, but to a smaller extent and from low levels. In the intensive-cropping region the use of pesticides is essentially unchanged compared to the REF scenario. The per-hectare use changes with the same proportions as total use in all regions, since the number of utilised hectares remain unchanged compared to the REF scenario. Thus the environmental problems stemming from use of pesticides will not be addressed by simply abolishing Pillar I direct payments or a payment for marginal land. Targeted measures are necessary to address these problems.

Impacts on biodiversity

The payment for marginal land has the effect of preserving land that would otherwise be abandoned and overgrown if Pillar I direct payments were simply abolished. Consequently, the decline in biodiversity that occurs in the NO DIRECT PAYMENTS scenario is avoided in the PUBLIC GOODS scenario; biodiversity is largely unaffected by the elimination of direct payments when a payment linked to marginal land is simultaneously introduced. Some decline remains in the mixed-farming region, because of transformation of some fallow land into production of grains for fodder. However, the majority of the decline observed in the NO DIRECT PAYMENTS scenario is avoided, which is explained by the preservation of agricultural land thanks to the public-goods payment. Of particular benefit to biodiversity is the preservation of semi-natural pasture in the mixed-forestry and mixed-farming regions.

6

Summary and conclusions

Challenges facing European agriculture are broad, particularly

- improving productivity and competitiveness to foster income development;
- provisioning of public goods such as preservation of biodiversity and cultural landscapes, and future food security; and
- moving towards sustainable food and bioenergy production through judicious use of artificial inputs and natural resources, as well as reducing agriculture's contribution to environmental degradation and climate change.

Efficient provisioning of public goods is not likely to be achieved by relying on markets for agricultural products, while sustainable and low emissions production is likely to be costly for farmers in the short term. These two potential market failures provide good reason for policy responses, while the role of policy in relation to improving competitiveness and incomes is less clear.

In the introductory chapters we concluded that these challenges are likely to be poorly addressed by the current instruments of Pillar I, particularly the direct payments. Furthermore, the prospects of significantly improving the efficiency of direct payments for achieving CAP objectives are equally poor: specific problems are better addressed by targeted policy instruments. Replacing Pillar I's broad instruments with more narrowly defined instruments has the potential to achieve multiple objectives and avoid goal conflicts, because it avoids the fallacy that a single broad or universal instrument can deliver on all objectives.

The aim of this report has been to analyse the economic and environmental impacts of the Pillar I direct payments, and to demonstrate alternative instruments that are better suited to achieve CAP objectives. The instruments—a targeted payment to land providing public goods and at risk of abandonment, and a tax on mineral fertilisers—were selected on the basis of the Polluter Pays and Provider Gets Principles.

The future of the CAP after 2020 has been intensively debated and several reform proposals advanced. Our ambition is to contribute to that debate. We do not propose, however, a blueprint for a new CAP, but to identify, analyse and discuss selected but highly relevant issues for CAP design. What makes our report different is that we use two complementary models of European agriculture to quantify the impacts of Pillar I direct payments at different spatial scales; the smaller the scale we analyse (using AgriPoliS) the greater the details of local conditions considered, whereas EU scale effects are determined more broadly (using CAPRI). We used this approach because it is infeasible to quantify both aggregate EU-level impacts and local impacts with a single model. Accordingly the local analyses are based on a set of case-study landscapes that we believe are representative of the diversity of agricultural and environmental conditions under which EU farmers operate. A quantitative approach is necessary because it is not possible to generalise about the significance of the impacts of direct payments, as the spatial heterogeneity in conditions across the EU implies they will vary from region to region. In this way we were able to quantify the impacts of direct payments, and explore potentially more efficient alternatives.

6.1 Important caveats

Despite our use of state-of-the-art models and comprehensive empirical data, modelling involves by its nature simplifying assumptions. Consequently the results are uncertain, particularly the exact sizes of impacts, but we believe that the direction of impacts and their magnitudes are well identified. We observe though that AgriPoliS generally indicates larger impacts than CAPRI. The explanation is found in differences in methodology. For one because CAPRI simulates aggregate impacts, it averages out differences across farms and regions, whereas AgriPoliS is

used to analyse impacts for individual farms and smaller regions. Since neither model is likely to be "the true model", these differences illustrate a range of uncertainty in the results.

Our case-study regions are located in Sweden, and hence may not capture all types of diversity in the EU. Therefore, while we expect our conclusions to apply to regions characterised by the general characteristics of our study regions—intensive or extensive farming, specialised arable cropping or pasture based livestock production, consolidated or fragmented agricultural land, etc.—we would still expect that particular concerns for particular regions would need to be addressed by targeted policy responses, and not by general instruments such as direct payments.

An important strength of targeted instruments such as those we demonstrate is that they provide farmers with incentives to innovate, i.e., to achieve outcomes they are paid for at lower cost over time. The technologies modelled, however, cannot be improved over time as they could be in reality. Accordingly the simulation results say nothing about the potential for realising innovations. For instance the fertiliser tax simulations assume that the nutrient loss-rates associated with storage and application of manure are fixed. In reality, a fertiliser tax would more than likely lead to more efficient use of manure through technological innovation and adoption, thus reducing emissions further. Similar incentives could also be created for, say, conserving biodiversity, where farmers learn to improve habitat for endangered species or lower the costs of applying conservation measures. In fact, this is a vital advantage of targeted instruments over general instruments, but obviously the potential impacts are very difficult to predict. There is though ample evidence in the environmental policy literature that these impacts can be significant and reasonably expected.

6.2 Summary of simulation results and conclusions

Challenge i) On productivity, competitiveness and income development

According to our simulations, direct payments have substantial positive and negative impacts. First, more land (6.5 per cent of the EU's area according to CAPRI) is kept in agriculture, but with very large regional variation. Detailed results from our case-study regions reveal that up to 50-60 per cent of land is maintained in marginal regions (according to AgriPoliS), particularly environmentally and culturally valuable semi-natural pastures, whereas relatively productive arable land is used in production in any case. The associated larger agricultural output, however, results in lower output prices which is detrimental to competitiveness and farm incomes.

Secondly however, direct payments significantly slow structural change, thereby hindering farms in our study regions from increasing their land area (as expansion necessitates some farms closing down) and exploiting economies of scale, which would improve productivity and increase farm profits. As a result of lower prices and slower structural change the €41 billion transferred from taxpayers to farmers as direct payments gives only €36 billion, or 21 per cent, higher aggregate income in the EU.

Conclusion 1

Pillar I direct payments avoid land abandonment but at the cost of slowing structural change. This goal conflict hampers development of a productive and competitive sector, thereby constraining income growth, primarily in relatively productive regions.

Challenge ii) On biodiversity, cultural landscapes and future food security

Simulations in our representative study regions show that direct payments predominantly contribute to the maintenance of low-yielding arable land and semi-natural pastures (i.e. marginal land), as this land is not profitable enough to farm without payments to land. Maintaining this land is important for conservation of biodiversity, with almost 25 per cent more endangered species being conserved in the marginal mixed-

forestry region and 13 per cent more in the less marginal mixed-farming region (according to our species-area-based biodiversity indicator). In particular, these endangered species are reliant on the preservation of extensive grazing activities on semi-natural pastures, a form of High Nature Value farmland, which direct payments contribute to protecting.

Maintaining these large areas of farmland also contributes to the preservation of cultural landscapes, which are often dependent on traditional farming activities such as extensive grazing by ruminants. Finally, maintaining this land also contributes to future food security since land in these regions would otherwise revert to forest—the natural and dominating land use in Sweden.

Conclusion 2

Pillar I direct payments contribute to the provisioning of the public goods biodiversity conservation, cultural landscape preservation and food security, by averting abandonment of land that is relatively extensively farmed and hence typically found in marginal regions.

To counteract the negative impacts of direct payments on agricultural development we demonstrate the potential of introducing a more targeted payment with the explicit purpose of financing the provisioning of these public goods. Our results indicate that a targeted payment for public goods will keep about the same area of land in agricultural use as the direct payments, and at a budget saving of €15 billion compared to current Pillar I direct payments. However, it must be realised that our modelling only allowed a fairly rough targeting of the public-good value of avoiding land abandonment at the EU level, since the payment targeted marginal land generally. In practice it would be possible with today's GIS-based monitoring and control systems to achieve a much finer degree of targeting, and hence potentially radically improving on our modelled cost savings.

Conclusion 3

Replacing direct payments with more targeted payments for the provisioning of public goods, according to the Provider Gets Principle, would resolve the current goal conflict of balancing a competitive agricultural sector with the provisioning of public goods.

Challenge iii) On sustainable production and environmentally damaging emissions

Direct payments result in higher greenhouse gas emissions, nutrient surpluses and pesticide inputs in the EU by 2.3 to 2.5 per cent, which indicates that Pillar I is contributing to climate change and water pollution, rather than mitigating these serious environmental problems. This is because the payments result in more agricultural production and total inputs of mineral fertilisers and pesticides than otherwise would be the case.

Conclusion 4

Pillar I direct payments result in higher greenhouse gas emissions, nutrient surpluses and pesticide inputs than would otherwise be the case.

To test the potential of a policy targeted on reducing emissions we simulated a mineral fertiliser tax that increased the price of nitrogen and phosphorous content in fertilisers by 25 per cent across the EU. The fertiliser tax reduced nutrient surpluses by an additional 2.4 and 2.2 per cent respectively (compared to simply eliminating direct payments). A mineral fertiliser tax is an example of a targeted instrument according to the Polluter Pays Principle, but a tax alone cannot be expected to result in the dramatic emissions reductions required to improve water quality in the EU. Other complementary measures are needed such as those available as voluntary Agri-Environment Schemes (AES). For example to improve uptake of Agri-Environment Schemes in intensive regions (which

is currently poor) payment levels could be increased to better reflect the opportunity costs of arable farmers, through say the budgetary savings achieved by replacing Pillar I direct payments with a targeted public-good payment.

Conclusion 5

A menu of targeted instruments such as payments for public goods and emissions taxes are needed to substantially improve environmental quality in the EU and lower the associated costs.

6.3 General reflections

Pillar I direct payments inadequately addressing future challenges

Our simulation results broadly support the general, qualitative conclusion of chapter 2, that Pillar I direct payments create goal conflicts and that these are substantial. In particular, direct payments dramatically slow structural change which hampers productivity growth and income development (**Conclusion 1**). On the other hand, they avoid abandonment of marginal land which is important for the provisioning of public goods (**Conclusion 2**). When it comes to challenges associated with land use, and in particular with the provisioning of public goods such as biodiversity, we investigated the capacity of a Provider Gets payment targeted on marginal land to avoid land abandonment.

The new instrument was found to be capable of preventing much of the land abandonment that would occur if direct payments were simply abolished (**Conclusion 3**). The public-good payment analysed in this study, albeit more targeted than direct payments, is though still fairly broad. More efficient schemes would ultimately target land that otherwise is at risk of abandonment, but not at a higher rate than the cost of maintaining it, and certainly not at a higher rate than the value of the public goods provided. Defining the latter is certainly no trivial matter, and one which was beyond the scope of this study.

The simulations also demonstrate that the direct-payments instrument does not even work in the right direction when it comes to meeting important environmental challenges, such as reducing green-house gas emissions. Rather our results suggest that the direct payments are contributing to pollution rather than reducing it (**Conclusion 4**). The analysis of the fertiliser tax provides an example of how a narrowly defined instrument can better contribute to meeting the emissions challenge while adhering to the Polluter Pays Principle.

The fundamental flaw with direct payments as an instrument to efficiently procure public goods or emissions reductions is that it fails to account for the large spatial variability in agricultural and environmental conditions in the EU, and fails to link payments to evidence of actual environmental improvements. Rather targeted instruments are needed to achieve CAP objectives cost-effectively (**Conclusion 5**). In essence direct payments are a payment to farmers for being farmers, some of whom, but far from all, are providing Europeans with environmental and cultural services as claimed. Indeed, even intensive farming that primarily has negative impacts on the environment and generates these farmers a good market income, are eligible for the same payments. Consequently, a substantial proportion of direct payments go to a minority of farmers in relatively productive regions where the need is least. On the contrary, the need for support is real in marginal regions, because some form of payment to marginal land is required to avoid its abandonment and the loss of associated public goods.

Further, the direct payments even come at the cost of lower market returns for farmers due to the slower structural change (smaller and less competitive farms) and lower output prices (due to greater EU output). On the other hand the lower output prices lead to somewhat lower food prices, but at the greater cost of financing the direct payments.

The simple reason why a general instruments such as the Pillar I direct payments cannot work as an instrument of environmental policy, is the extreme spatial variation in agricultural and environmental conditions that confront European farmers, which is confirmed by the large region-

al variation in the impacts of direct payments found in our results. For instance one of our study regions is dominated by low-yielding and low-input grassland and another has average wheat yields of 8 tons and associated high-input application rates, differences that are typical for the EU. Such a broad policy is clearly inappropriate to tailor to such large differences. Our general insights though are hardly new, there are many others calling for reform of the direct payments system and providing a diversity of prescriptions, for similar reasons.

Ostensibly it is an egalitarian thought to pay all farmers equally, but soil productivity which underpins crop yields and farm area which determines total payment receipts, are far from equal in the EU, resulting in a system that accentuates wealth inequality rather than moderating it. A general payment for being a farmer therefore fails miserably on fairness grounds. Payments based on the Polluter Pays and Provider Gets Principles are fairer.

Simply abolishing direct payments is not a silver bullet

Abolishing the Pillar I direct payments will not only produce positive impacts but negative impacts as well. In particular, it is not sufficient for ensuring the provisioning of public goods and dealing with environmental degradation. This is because less productive farms that generate public goods are most likely to go out of business, such as extensive pasture-based lamb and beef producers; and profitable farms that survive will be given no new incentives to reduce the intensity of production (e.g., through reducing chemical and fertiliser application rates). On the contrary, induced increases in output prices will boost the optimal intensity of production and thereby cause higher levels of polluting emissions on the land kept in production.

An important reason why simply abolishing direct payments in Pillar I will in itself not solve these problems, is the fact—reiterating from above—that agricultural and environmental conditions vary across the EU. Indeed, we demonstrate that the impacts of direct payments vary dramatically among regions and farming systems; from almost no impacts on production in highly productive, intensively farmed regions, to

wide-scale abandonment of marginal land and elimination of extensive livestock grazing that is crucial for maintaining biodiversity and cultural landscapes in other regions.

The sheer magnitude of Pillar I direct payments results in a larger agricultural sector income than otherwise would be the case. However, the accompanying negative impacts on the structural change process culminate in a less efficient agricultural sector with lower and less sustainable incomes for the associated larger population of farmers. Currently structural change is slowed by the link between direct payments and agricultural land. Thus abolishing direct payments would improve the competitiveness of European agriculture and generate higher incomes for those farms that survive. Without some farms leaving the sector other, potentially more efficient farms, are not able to acquire the additional land that is necessary for increasing agricultural productivity and hence incomes through farm expansion.

To summarise, even though Pillar I direct payments are heavily criticised for their ineffectiveness, simply abolishing them is clearly not a silver bullet for alleviating its troubles. Yet abolishing the direct payments would improve the competitiveness of the sector and free funds for financing new targeted instruments that have the potential to avoid goal conflicts and meet future challenges.

Procuring public goods and reducing emissions efficiently requires targeted instruments

According to our simulations the Pillar I direct payments deliver substantial flows of public goods in marginal regions, but augment environmentally harmful emissions generally. The objectives of procuring public goods and reducing environmentally harmful emissions would be more efficiently supported through targeted instruments, following the Polluter Pays and Provider Gets Principles. Indeed we demonstrate that there are alternatives available to Pillar I direct payments that would achieve these objectives and at substantially lower cost to society.

By basing a new, land management payment on evidence of the delivery of public goods (e.g., by targeting marginal regions and land that meets certain conditions) it would address the fundamental weakness of using Pillar I as an instrument of environmental policy; the lack of consideration of spatial or regional variability in agricultural and environmental conditions.

Further, either maintaining or abolishing the Pillar I direct payments won't be sufficient to resolve emissions problems, because most production and its intensity will be largely unaffected. Again, we point to the general analysis in chapter 2, arguing that customised instruments that target pollution abatement are urgently needed. In this vein we show that a moderate fertiliser tax would reduce nutrient surpluses, but it is far from sufficient on its own to achieve environmental objectives, but would need to be complemented with other measures that mitigate the environmental damage caused by nutrient surpluses.

6.4 The way forward

Attempts to improve the environmental performance of Pillar I direct payments, specifically cross-compliance and greening, has resulted in an inefficient and complicated system. Above all, the division between what farmers are expected to do without additional payments and what they are to be compensated for is not based on sound and fair principles. We argue that environmental instruments should rely on a consistent application of the Polluter Pays and Provider Gets Principles. This is not the case today. The demonstrated payment to marginal land (our indicator for public goods) and a mineral fertiliser tax adhere to the Provider Gets and Polluter Pays Principles respectively. We demonstrate that these instruments have the potential to both avoid current goal conflicts and achieve environmental objectives more cost-effectively.

The ambition to keep marginal land at risk of abandonment in *Good Agricultural and Environmental Condition* (GAEC) could probably be accomplished by relatively simple, common rules across Member States. Hence, the demonstrated public-goods payment could be part of Pillar I, although it is not dependent on maintaining the pillar structure. Need-

less to say, agricultural land should not be preserved at any cost or under any circumstances. For instance, afforestation can in some situations be beneficial for the environment, especially where land use is dominated by agriculture and forests are scarce (Navarro and Pereira, 2012). The budgetary resources saved if direct payments are replaced by payments to marginal land can also be used for other purposes, for example higher compensation for Agri-Environment Schemes with low uptake in intensively farmed areas or risk management instruments, or something else entirely.

Further, if direct payments were replaced by, for example, a payment to marginal land, an implication is that not only the greening payment but also the cross-compliance requirements and the financial incentives to comply with the *Statutory Management Requirements* (SMR) would disappear. As a consequence, no incentives to comply with the GAEC requirements or the Basic Provisions in EU Regulation No 1307/2013 would remain. In this case, a solution would be to transform GAEC rules to statutory requirements comparable to the present SMR. In the case of the SMR, the incentives to observe the laws would need to be strengthened, or rather restored. This includes both the level of penalties and the frequency of controls. The penalties should be based on the principle of proportionality between the offence and the fine, and apply equally to all farmers. Moreover, all farmers should be obliged to observe the SMR, GAEC obligation and the Basic Provisions for eligibility in EU Regulation no 1307/2013.

Accordingly eliminating direct payments and associated cross-compliance does not imply a removal of the environmental laws (SMR) and the obligation to follow them. Still, cross-compliance was introduced to improve environmental performance by creating an *additional* incentive to follow the law. There is an obvious danger that removing cross-compliance may impair law obedience since the associated penalties will cease to exist. Hence, it is of vital importance that Member States ensure that the common environmental laws are followed through appropriate controls and adequate penalties that should follow the severity of the offence.

Today, the EU faces major challenges. Distributing payments to farmers universally without considering regional diversity in agricultural and environmental conditions and thereby benefits for society, is a seriously inadequate principle for an efficient policy. Given the substantial negative impacts of direct payments identified here, it should be clear that replacing them with a menu of targeted instruments based on the Polluter Pays and Provider Gets Principles, would be more capable of meeting future challenges.

In the early decades after WWII, production subsidies in the form of price support worked their magic to boost production and the incomes of poverty stricken farmers. A ton of wheat or beef was easily measured no matter where or how it was produced, and farmers were paid for what they produced on delivery to market. In this system it was easy to see that taxpayers got what they were paying for; greater food supply and higher incomes for farmers. As well known, this policy was continued well beyond its use-by date and culminated in the grotesque butter mountains and lakes of milk that eventually lead to the elimination of price support.

Things are now different in Europe which not only has some of the most productive and profitable agriculture on the globe—as well as some of the least productive—but is also a major exporter of food. The challenge faced by European agriculture today is therefore not so much to produce sufficient food at affordable prices for consumers, but how it is produced, particularly:

- competitively, which guarantees higher and sustainable incomes.
- maintaining extensive production that underpins provisioning of public goods.
- with less emissions, which reduces environmental damage and global change.

A general payment in the form of the Pillar I direct payments is an ineffective instrument to deliver on these challenges. Instead it needs to be replaced by targeted instruments that are better equipped to deal with today's challenges.

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