CROP ROTATION

Benefiting farmers, the environment and the economy

Pesticide Action Network Europe

Friends of the Earth Europe

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Executive summary

Farmers worldwide have rotated different crops on their land for many centuries. This agronomic practice was developed to produce higher yields by replenishing soil nutrients and breaking disease and pest cycles. The increase in monoculture cropping, where the same crop or type of crops are grown in the same field over several years, has been a growing trend in farming in recent decades. The European Commission, as part of its reform of the Common Agricultural Policy (CAP), proposes to support *crop diversification*, as a measure under the so called greening component. But this measure will not improve the environmental performance and long-term viability of European arable cropping systems. To ensure sustainable farming *crop rotation* with legumes must be introduced instead.

The benefits of crop rotation for farmers and the environment

Crop rotation has many agronomic, economic and environmental benefits compared to monoculture cropping. Appropriate crop rotation increases organic matter in the soil, improves soil structure, reduces soil degradation, and can result in higher yields and greater farm profitability in the long-term. Increased levels of soil organic matter enhances water and nutrient retention, and decreases synthetic fertiliser requirements. Better soil structure in turn improves drainage, reduces risks of water-logging during floods, and boosts the supply of soil water during droughts. Moreover crop rotation effectively delivers on climate change mitigation. Incentivising leguminous production in Europe will also reduce our dependency on imported soy protein feeds whose cultivation leads to large negative environmental and social externalities such as greenhouse gas emissions and displacement of indigenous people.

Crop rotation is used to control weeds and diseases, and limit insect and other pest infestations and as a result significantly reduce pesticide use. Leguminous crops in the rotation fix atmospheric nitrogen and bind it in the soil, increasing fertility and reducing the need for synthetic fertilisers and the use of pesticides.

Implementation and monitoring of crop rotation in Member States

Many countries already include crop rotation as one of their farmers cross compliance obligations under the current CAP. These Member States check crop rotation through their existing IACS (Integrated Administration and Control System) systems.

Furthermore Member states are required to use a Geographical Information System (GIS) as part of ICAS in order to effectively observe and process the distribution of CAP payments. This means that Member States already can implement and monitor crop rotations.

The new CAP needs a clear commitment to crop rotation

- Ensure that the greening component delivers effective measures including the introduction of crop rotation as part of a simple agronomic package under the first pillar.
- Require farmers to dedicate at least 15% of the farm's arable area for nitrogen fixing leguminous crops as part of their crop rotation.
- Provide comprehensive advice on crop rotation and leguminous crop cultivation under Member States' Farm Advisory Systems.
- Strengthen support for farming activities across pillar I and II which encourage crop rotation and leguminous cultivation that benefits the environment, such as organic farming.

1. Introduction - crop rotation and the role of the CAP reform

As a cornerstone of good agronomic practice, crop rotation has a clear role to play in a sustainable CAP. Not only can it reduce farmers' production costs, it has multiple environmental benefits, including the protection of water, the improvement of soil quality, contributing to climate change mitigation and reducing input dependency.

The proposed *crop diversification* measure under the Commission's legislative proposals[1] however will not lead to all these desired benefits. Therefore a *crop rotation* measure, including clear requirements for farmers to grow locally or regionally appropriate legume crops needs to be put in place.

EU protein crop production currently occupies only 3% of the EU's arable land and supplies only 20% of the protein crops consumed as animal feed domestically, contributing over the past decade to the EU's protein deficit. The European Parliament adopted a report in February 2011 calling for increased protein crop production.[2]

This briefing firstly shows how promoting crop rotation can support sustainable yields and ensure stable incomes for farmers in the long-term. Secondly it examines how the current proposals could be a potential backwards step in terms of providing support for the development of effective crop rotation systems.

2. Crop rotation versus crop diversification

The greening component under the proposed CAP reform suggests that 30% of direct payments should be linked to a simple package of measures to reduce GHG emissions, combat monocultures and increase biodiversity. These measures include crop diversification as well as the preservation of permanent grassland and the recognition and integration of ecological infrastructure on the farm (covering 7% of farmland).

Standards for crop rotation have specifically been implemented as part of 'good agricultural and environmental condition' (GAEC) to fulfil cross-compliance[3] requirements in a number of member states since 2003[4]. In its legislative proposals the Commission has removed these optional for Member States standards for crop rotation under cross compliance and put forward a new *crop diversification* measure under the greening component.

The replacement of standards for crop rotation under cross-compliance with a crop diversification measure under the greening component would be counterproductive, as it would undermine the work of Member States which currently enforce crop rotation, and have implemented crop rotation systems which deliver positive results for farmers and the environment.

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[1] European Commission, 2011. Proposals for a Regulation of the European Parliament and the Council establishing rules for direct payments to farmers under support schemes within the framework of the common agricultural policy: http://ec.europa.eu/agriculture/cap-post-2013/legal-proposals/com625/625_en.pdf

[2] http://www.europarl.europa.eu/sides/getDoc.do?type=REPORT&reference=A7-2011-0026&language=EN

[3] A set of rules that farmers need to comply with to qualify for receiving direct payments in COUNCIL REGULATION (EC) No 1782/2003 of 29 September 2003, annex IV, and in Council Regulation (EC) No 73/2009, annex III.

[4] Germany, Italy, Poland, UK, Romania and others currently offer regional or national standards for crop rotation under GAEC; See FoEE (2009) Overview of Member States applying crop rotation as one of their 'good agricultural and environment conditions' (GAEC) in 2009 based on information from DG AGRI with countries and their type of crop rotation, http://www.foeeurope.org/sites/default/files/foee_ms_gaec_overview_crop_rotation_2009.pdf

Crop diversification, however, differs significantly from crop rotation: The crop diversification measure proposed states that a farmer must have three different crops on his or her land, with no crop covering more than 70%, or less than 5%, of the total arable area. The measure, however, does not include any requirements to apply agronomic practices, such as specifying the appropriate types of crops, or rotating different crops in the same field that would deliver genuine benefits for farmers. Moreover the limits set in the proposal will not change monoculture cropping practices found in a many cereal-based cropping systems across Europe.

Under the current proposals a farmer with 100ha of land could plant 70ha of maize, 25ha of wheat and 5ha of barley annually, and repeat that over subsequent years. This type of "diversification" would not be enough to break monocultures, or result in the agronomic and environmental benefits of rotations in annual cropping systems.

3. Financial benefits to farmers

The European Commission's CAP Impact Assessment fails to both estimate the actual costs of crop rotation, or take into account the long term benefits from increasing yields that crop rotation is likely to bring, as it only counts the costs that could be imposed on farmers who move to crop diversification. This omission is disappointing as several studies have shown that any short term costs from re-introducing crop rotations with legumes can be offset by long term increases in yields[5].

For example, studies that compare the margins for farmers who grow maize and wheat monocultures and include other crops in rotation show that farmers who have maize every 2 or 4 years on their fields can have higher margins compared to maize or wheat monocultures.[6]

4. The multiple benefits of crop rotation

Crop rotation has a number of agronomic, economic and environmental benefits compared to monoculture cropping. These include:

Improved soil structure - with higher levels of organic matter and better water provision resulting in **higher yields in the long-term.**

Enhanced pest and disease control – as producers use fewer inputs to fight pests, and so can decrease both costs and environmental impacts due to the **reduction in pesticide use.**

Smarter use of nutrients – creates a more balanced nutrient cycle at the field level and helps farmers **to use fewer inputs to maintain nutrient availability**. This results in lower costs and increased profit margins. For example, using legume crops in the rotation can reduce the need

[5] A 6-years study show that continuous maize under high chemical and soybean-maize-maize and soybean-maize rotations under low chemical management has similar net returns in ridge tillage (26 EUR, 20 EUR, 13 EUR/ha respectively), Environmental impacts of crop rotation in the EU, European Commission DG ENVI, page 87; GL-Pro, 2005. Guidelines for growing grain legumes in Europe. GL-Pro Concerted Action; Nemecek et al (2007). Environmental impacts of introducing grain legumes into European crop rotations, November 2007

[6] Ibid, p. 80ff

for additional synthetic nitrogen fertiliser, lowering costs for farmers, reducing water pollution from runoff and in some cases providing farmers with an extra income stream.[7]

Reduced greenhouse gas emissions – creating better nutrient management through crop rotation can **decrease nitrogen fertiliser use by up to 100kg N per ha per year**, substantially lowering related greenhouse gas (GHG) emissions.[8] Nitrous oxide has a global warming potential 310 times greater than CO_2. Reduced synthetic fertiliser use also leads to reduced greenhouse gas emissions from the manufacturing process and transportation.[9]

Reduced water pollution - limiting the input of large applications of synthetic fertilisers will decrease water pollution caused by **nitrogen, which costs an estimated 70 to 120bn Euro per year to clean up in the EU.[10]** Diversified rotations and rotations with a high share of crops and a low dependence on pesticides (eg. clover, lucerne) also reduce pesticide use and potential run off into groundwater.[11]

Increased ability to store carbon - crop rotation practices can lead to **higher soil-carbon content through increased crop cover periods** (using catch crops), reduced tillage intensity and frequency. Increasing the use of forages in crop rotations can also lead to better crop residue management, while[12] higher soil-carbon content contributes to combating climate change.

Contribute to equitable farming systems globally – reducing the EU's use of external inputs like feedstuffs, fertilisers, pesticides and fuels will contribute towards a more equitable global farming system. Currently, **80% of protein animal feed for European livestock is imported from developing countries and externalises the negative environmetal and social impacts** on other regions in the world. Crop rotations would therefore be one way to meet our international obligtions to reduce GHG emissions and our importation of natural resources from developing countries.

Reduced health care costs - studies in the **UK and Germany** have conservatively estimated **annual external costs of pesticides use to be 209 million and 135 million Euro**, respectively, paid by sufferers of pesticide-related poor health, the environment and citizens[13].

These benefits are supported by a European Commission study which outlines an extensive list of reasons in favour of crop rotation in the EU. This includes improving or maintaining soil fertility, limiting erosion, reducing the build up of pests, spreading the workload over time, mitigating risk of weather changes in terms of yield variation, limiting dependence on agricultural chemicals[14].

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[7] S.A.Khan et al. J. Environ. Qual. 36:1821-1832, 2007: "*The myth of nitrogen fertilization for soil sequestration"* science; Value of crop rotation in nitrogen management by Mahdi Al-Kaisi, Department of Agronomy; Do I need to till my soil? by Mahdi Al-Kaisi, Assistant Professor, Department of Agronomy, and Don Reicosky, soil scientist, Department of USDA-ARS North Central Conservation Research Laboratory; French Ministry of Ecology and Sustainable Development (2010). *Environmental and agronomic advantages of a revival of legumes in France*, Le point sur Number 40, January 2010

[8] French Ministry of Ecology and Sustainable Development (2010). *Environmental and agronomic advantages of a revival of legumes in France*, Le point sur Number 40, January 2010.

[9] Ibid

[10] Sutton et al (2011): The European Nitrogen Assessment, at *http://www.nine-esf.org/ENA-Book*

[11] Environmental impacts of different crop rotations in the European Union, European Commission DG ENV (2010), online at:http://ec.europa.eu/environment/agriculture/pdf/BIO_crop_rotations%20final%20report_rev%20executive%20summary_.pdf, p. 49-75.

[12] Hutchinson, J.J., Campbell, C.A., and Desjardins, R.L., (2007): Some perspectives on carbon sequestration in agriculture. Agric. Forest Meteorol. 142, 288-302.

[13] Pretty, J.N., H. Waibel (2005). Paying the price: the full cost of pesticides. In: Pretty, J.N. (Ed.) The Pesticide Detox. London, Earthscan, pp. 39-54

[14] Environmental impacts of different crop rotations in the European Union, European Commission DG ENV (2010), online at:http://ec.europa.eu/environment/agriculture/pdf/BIO_crop_rotations%20final%20report_rev%20executive%20summary_.pdf, p. 49-75.

5. Is it really so difficult to check that crop rotation is being practiced?

Many of the barriers to introducing crop rotation in the CAP reform are based on the perception that monitoring and controlling crop rotation at farm level will be burdensome and difficult to implement across the EU. One argument, for example, used against including crop rotation in the CAP reform is that crop rotation is a multiannual commitment, whereas payments under pillar I are made annually, therefore it is impossible to apply such a measure. However this does not stand up to closer scrutiny as a number of member states already support national and regional requirements for crop rotation under cross compliance and other requirements, notably the maintenance of “permanent pasture”, span over more than one year and require the cross-checking the records of aid applications over consecutive years.

In order to check crop rotation, farmers are required to declare in the aid application form the type of crop being planted, which is then cross checked against data in the IACS. Cross checks with the previous year's declaration would allow national and regional authorities to determine whether a farmer is rotating crops on the same parcel from year to year. These kind of "administrative" checks need no inspectors as they are carried out between databases within the IACS.

Each parcel has a unique identifier, so crop codes in the IACS enable the information in the farmer's annual aid application form to be used in automated administrative checks including which crop is being grown on which parcel, in which year. Crop codes were in place in all Member States before 2005, and are still used in many Member States who need to identify crops to check eligibility for certain schemes or because of the GAEC rules they have chosen to implement.

Crop codes are used, for example, in France for crop rotation schemes for both annual payments under article 68 of the current direct payments regulation and multi-annual payments under agri-environmental measures in the rural development regulation. In Austria, to check crop rotation in certain agri-environmental measures, the authorities allow the crop of the current year's parcel to be cross-checked with the crop of the previous year.

Poland has also carried out systematic administrative cross checks on crop rotation on all arable parcels on all farms since it introduced cross compliance while Slovenia carries out effective monitoring using remote sensing comparing satellite images with the IACS.[15]

Crop rotation could also be checked on the application form, where the paying agency introduces a simple tick box where the farmer would declare whether he or she has rotated between the current year and the last. This is based on trust and assumes farmers really comply with the rules, rather than just ticking a box. While such a method may be open to abuse the normal eligibility checks in which 5% of the total applicants in every Member State have on-the-spot checks would allow inspectors to check against previous years' applications or check for traces of the previous year's crops in the field.

[15] To see more examples for monitoring crop rotation from Slovenia and Spain see presentation by Simon Kay, JRC, Monitoring Agricultural Resources Unit:
http://www.europarl.europa.eu/document/activities/cont/201108/20110831ATT25703/20110831ATT25703EN.pdf, p. 85

How do control systems work? IACS, aid application forms and LPIS-GIS

The current CAP requires Member States to have an Integrated Administration and Control System (IACS), to check that what a farmer declares matches what he or she is actually practicing on the ground by cross-checking the farmer's declaration against up to date records. One of those records is the Land Parcel Information System (LPIS), which is based on existing land registers. Since 2005 each LPIS was required to incorporate a Geographical Information System (GIS) that inspectors and administrations would use to check eligibility of claims and keep updated. Using a GIS the LPIS is now made up of layers of information. As well as the field boundaries it includes extra layers of vectorised information such as orthographic photos, satellite images, landscape features, other topographic layers, water features, nitrate vulnerable zones, Natura 2000 sites, etc. The idea is that controls can be more effective by having information that is easily comparable or superimposed between layers.

Each field, or parcel, has a unique identifier in the LPIS-GIS. When a farmer declares that he or she is using a certain area of a parcel of land, it is put into their IACS application for aid, and the application data is then cross-checked against the official utilised agricultural area (UAA) in the LPIS-GIS land register. Many Member States and regions also oblige farmers to declare which crop they grow or how they use each parcel, and this application data is then entered into the IACS using a 'crop code' and is used in many Member States to control and monitor crop rotation as requirements for receiving CAP payments under the Pillar I and II. Most checks are automated, simply comparing data between different databases, and so require no farmer participation or inspector time.

IACS is used by Member States to identify and calculate agricultural land that is eligible for direct payments, but also as a tool for inspection and control for 5% of applicants for aid, either through remote sensing using satellite images in the LPIS-GIS, or by traditional field visits by inspectors who compare declared area with the facts on the ground and the LPIS-GIS. This arrangement works well in the vast majority of Member States and is unlikely to change under the CAP reform.

Since the last major CAP reform in 2003 1% of farms are also checked using these systems to see if farmers are meeting their obligations under cross compliance.

6. Crop rotation is possible under current trade rules

It is sometimes argued that trade rules prevent measures that support crop rotation and leguminous crop cultivation.

The Blair House Agreement made between the US and the EU in 1992 set the basic rules for the Agreement on Agriculture and common terms for their mutual agricultural trade relations and sets limits on the amount of oilseeds (soybean, sunflower seed and rapeseed) that can be grown for food and industrial use in Europe. This agreement is often used to argue that it is impossible for the EU to support domestic protein production (as a key part of a crop rotation), however, the Agreement only covers oilseeds and does not cover pulses (field peas and beans and lupines). Moreover this Agreement is based on market access interests and is incoherent with sustainability objectives.

The WTO rules are used as an excuse that leguminous or protein crops cannot be specified within a rotation as a pre-requisite of payment. However, this is not a robust argument. Firstly, the Commission's approach is inconsistent as they include measures in their own proposals which re-couple payments to production. Secondly, France carried out a highly successful "protein plan" under article 68 for increased production of protein crops.[16]

7. The role of the rural development measures

To complement the greening of the first pillar, measures in the second pillar are needed to fully support the more advanced crop rotation measures across the EU:

- It is fundamental that the European Innovative Partnerships on Agricultural Productivity and Sustainability (EIP) seriously supports initiatives which promote the research and development of new locally and regionally appropriate protein crops, alternatives to pesticides and breeding programmes.
- Robust education and training within Farm Advisory Systems should help to support all farmers in applying more advanced sustainable cropping practices and the use of non-chemical alternatives such as including agro ecological systems.
- Agri-environment, climate and organic farming measures should have enough ring-fenced funding to allow member states to support the development of a more advanced package of agronomic measures that can build upon crop rotation and legume cultivation.
- There should be additional measures to introduce improved, decentralised facilities and infrastructure for the production of animal feed, based on local and regional crop varieties, seed selection and development.
- Investment schemes should offer specific support to non-chemical methods of production such as biological control agents (e.g. beneficial insects, mites, nematodes), bio-pesticides, insect pest pheromones and various substances of natural origin such as natural plant resistance inducers, in combination with crop rotation to help overcome the costs of a transition to more sustainable cropping systems.
- Compensation via the proposed insurance schemes for climate-induced and/or natural disasters must only be paid to farmers who can demonstrate that they have taken a preventative agronomic approach to natural disasters by climate-proofing their production systems, starting with crop rotation.

[16] LMC International (November 2009). Evaluation of measures applied under the Common Agricultural Policy to the protein crop sector, at http://ec.europa.eu/agriculture/eval/reports/protein_crops/exec_sum_en.pdf

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