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Design principles of a Carbon Farming Scheme in support of the Farm2Fork & FitFor55 objectives

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In order to reach the objectives of the recently approved EU Climate Law, the agricultural sector has to simultaneously *reduce* significantly its level of emission, *increase* the amount of carbon it sequesters, and as much as possible, *augment* the share of biomass that can be used in substitution of fossil. In this perspective, the European Commission seeks to develop specific measures in order to support *carbon farming*, a concept that refers to business models in the agricultural sector that contribute to reaching the above-mentioned objectives.[1] This, at a time where other key objectives have been assigned to the agricultural sector by the Farm2Fork and Biodiversity strategies[2] in order to keep it within planetary boundaries. Against this backdrop, this *Policy Brief* lays down key design principles of a "Carbon Farming Scheme" that would simultaneously foster climate mitigation and be in support of the other objectives set forth by the Farm2Fork and Biodiversity strategies.

1 EC (2021). *Sustainable Carbon Cycles*. Brussels, Communication from the Commission to the European Parliament and the Council – COM(2021) 800., 22 p.

2 EC (2020). *Farm to Fork Strategy. For a fair, healthy and environmentally-friendly food system. Brussels,* Communication from the Commission to the European Parliament and the Council, 22 p.

KEY MESSAGES

To foster a sustainable transition of EU agricultural and food systems aligned with the Green Deal's objectives, a Carbon Farming Scheme (CFS) should target systemic transitions of farming systems, through the adoption of a multi-dimensional approach (beyond a carbon-focused one). The following criteria would need to be considered in such a perspective: an absolute reduction in all GHG emissions; enhance carbon sequestration in soils and agroecological infrastructures; foster the diversification of agroecosystems from plot to landscapes; and reduce the overall dependency of farming systems to external and synthetic inputs.

Such an approach could only deliver on climate & biodiversity objectives if associated with a reduction in the EU consumption and production of animal products, as animal feed consumes today the bulk of all the biomass (43%) used within the EU (*vs* 13% for food, 23% for biomaterials, and 20% for energy).

While the *farm* should be the smallest level of intervention (no practice change should be supported without considering the broader dynamics at the farm level), an effective approach to carbon farming should also be deployed at the *value chain* and/or *landscape* levels and involve collective organizations (interbranch organizations, producer organizations, local governments) capable of triggering systemic changes often difficult to obtain at the individual level (such as crop diversification and the reintroduction of leguminous crops). This approach to transition beyond the farm would also help to create irreversibility and thus facilitate the management of risks associated to the non-permanence of agricultural practices/soil carbon sequestration.

Funds dedicated to a CFS should primarily be directed to support systemic and sustainable transitions of farming systems on the basis of a clear and multidimensional evaluation/certification framework. In that respect, this framework should be deployed in a "taxonomic" way, i.e. to help public and private investors to identify the right projects to support.

POLICYBRIEF
N° 1
JANUARY
2022

1. A CARBON FARMING INITIATIVE TO SUPPORT SYSTEMIC TRANSITIONS OF FARMING AND FOOD SYSTEMS

A Carbon Farming Scheme (CFS) is defined in the Communication on Sustainable Carbon Cycles[3] and its supporting document[4] as "a green business model that rewards land managers for taking up improved land management practices, resulting in the increase of carbon sequestration [...] and/or reducing the release of carbon to the atmosphere". While the focus of the Communication is on how to increase carbon sequestration, both dimensions—sequestration *and* emission reduction —should be considered as per this definition. In that perspective, five areas of action have been identified (that are however partially cross cutting):[5] better management of peatland, development of agroforestry, maintain and enhance soil organic carbon, better management of livestock (feed and manure management), and better nitrogen/fertilization management. The first three areas encompass actions whose objective is to *sequester* carbon in different compartments of agroecosystems, while the others two have more to do with emission reductions in particular through *efficiency gains* and technological uptake.

In parallel, reaching the objectives of the Farm2Fork and Biodiversity strategies (F2F & BDS) will be necessary to maintain the productive capacity of our agroecosystems, already affected by climate change[6] and biodiversity collapse.[7] These targets include an absolute reduction in the use of synthetic inputs (both fertilizers and pesticides) and a strong (re)diversification of agroecosystems–from plots to landscapes (through the 10% target of landscape features and the 25% target of organic farming).[8] At the same time, reaching such targets will also be favorable to soil carbon sequestration and, to a large extent, to an increase in the efficiency of nitrogen use. They are, as such, fully supportive of the climate objectives.

On the other hand, changes targeting only/mostly carbon efficiency such as those falling within the two last areas of action above outlined–livestock and fertilization management–can have detrimental effects on ecosystems' health. This is in particular the case of the use of nitrification inhibitors or feed additives, whose widespread use is sometimes hypothesized as a cornerstone of highly ambitious climate scenarios:[9]

— Following the IPCC recommendation, the use of nitrification inhibitors aims at limiting the emission of N_2O resulting from N application. However, it also contributes to increase the emission and then the redeposition of ammonia in natural ecosystems–which has critical side effects on natural ecosystems–while this very same process is also responsible to indirect N_2O emissions undermining the overall climate effect of this technology.[10]
— Feed additives aim at increasing feed conversion efficiency while reducing enteric fermentation for ruminants and can lead to a 10-15% reduction of methane emission without impacting cow productivity. Yet, how these additives affect the quality of the manure and in turn agroecosystems (and in particular soils) where this manure is applied remains relatively unknown.[11]

Carbon farming initiatives should therefore prioritize practices that yield multiple benefits (e.g. climate and biodiversity ones) while minimizing risks. Yet, a significant reduction in the use of external inputs and a strong diversification of agroecosystems, as required by the F2F & BDS, are also likely to lead in the short run and under the current state of our knowledge to a slight reduction of the overall agricultural production.[12] In a context where long-term climate strategies also target increases in the supply of biomass for substituting fossil carbon (either for energy or industrial purposes), a CFS can only be successful if accompanied by a reduction in the production and consumption of animal products within the EU. Animal production indeed absorbs as of today 43% of the biomass consumed in the EU, *vs* only 13% directly used as food, 23% for industrial purposes and 20% for energy production. Since fossil carbon today constitutes 55% of the total carbon consumed in the EU or 550 Mt of C, and since this amount is to drop dramatically if we are to meet our climate targets, less carbon derived from biomass should be directed to livestock and priority should be given to "low opportunity cost biomass".[13] In that perspective, extensive livestock systems relying on non-food

3 EC (2021). *Sustainable Carbon Cycles*. Brussels, European Commission – Communication COM(2021) 800, p. 4.

4 EC (2021). *Sustainable carbon cycles for a 2050 climate-neutral EU Technical Assessment* Brussels, European Commission – SWD(2021) 450, 60 p.

5 See for example: EP (2021). *Carbon farming. Making agriculture fit for 2030*. Luxembourg, European Parliament, Policy Department for Economic, Scientific and Quality of Life Policies, 64 p.

6 Moore, F. C. and D. B. Lobell (2015). The fingerprint of climate trends on European crop yields. *Proceedings of the National Academy of Sciences* 112(9): 2670.

7 Aizen M.A., Aguiar S., Biesmeijer J.C. *et al.* (2019). Global agricultural productivity is threatened by increasing pollinator dependence without a parallel increase in crop diversification. *Global Change Biology*, 00, 1-12. Dainese M., Martin E.A., Aizen M.A. *et al.* (2019). A global synthesis reveals biodiversity-mediated benefits for crop production. *Science Advances*, 5 (10), 13.

8 One way to combine multiple objectives is the reintroduction of leguminous crops in rotation. It will indeed simultaneously decrease the recurse to synthetic nitrogen while increasing soil organic carbon sequestration through crop diversification. See for example Voisin A.-S., Guéguen J., Huyghe C. *et al.* (2014). Legumes for feed, food, biomaterials and bioenergy in Europe: a review. *Agronomy for Sustainable Development*, 34 (2), 361-380.

9 Searchinger T.D. (2021). *A Pathway to Carbon Neutral Agriculture in Denmark*. Washington, World Resources Institute, 166 p.

10 Erisman J.W., Sutton M.A., Galloway J. *et al.* (2008). How a century of ammonia synthesis changed the world. *Nature Geoscience*, 1 (10), 636-639; Lam S.K., Suter H., Mosier A.R., *et al.* (2017). Using nitrification inhibitors to mitigate agricultural N2O emission: a double-edged sword? *Global Change Biology*, 23 (2), 485-489.

11 Bampidis V., Bastos M., Christensen H., *et al.* (2019). Guidance on the assessment of the safety of feed additives for the environment. *EFSA Journal*, 17 (4), e05648.

12 Barreiro-Hurle J., Bogonos M., Himics M. *et al.* (2021). *Modelling environmental and climate ambition in the agricultural sector with the CAPRI model. Exploring the potential effects of selected Farm to Fork and Biodiversity strategies targets in the framework of the 2030 Climate targets and the post 2020 Common Agricultural Policy*. Luxembourg, Publications Office of the European Union & Joint Research Centre of the European Commission.

13 Van Selm B., Frehner A., de Boer I.J.M. *et al.* (2022). Circularity in animal production requires a change in the EAT-Lancet diet in Europe. *Nature Food*, 3 (1), 66-73.

BOX. SOIL CARBON SEQUESTRATION & CLIMATE NEUTRALITY IN THE EU LAND SECTOR

Annual emissions from the agricultural sector amounts to 430 $MtCO_2$eql/y. To this has to be added emissions from agricultural soils themselves—60 to 70 $MtCO_2$eql/y—meaning that as of today EU agricultural soils are net emitters of GHG. The priority is thus to halt soil mineralization. In terms of soil carbon sequestration potential, estimates span from 42 $MtCO_2$eql (figure proposed by the Commission) to over 200 $MtCO_2$eql/y for the entire EU. Those figures are very sensitive to the hypotheses on practice changes *versus* more systemic changes of farming systems. They however well illustrate that even under the most optimistic assumptions for soil carbon sequestration, strong emission reductions will be needed in the sector to achieve the objective of land climate neutrality set forth by the EU by 2035.

competing feedstuff–and in particular extensive grasslands–should be prioritized over other sorts of systems for both the ecosystem services they render (nutrient cycling and landscape management) and their contribution to climate goals.[14]

2. DESIGN PRINCIPLES OF A CARBON FARMING SCHEME IN SUPPORT OF SUSTAINABLE TRANSITIONS

The need for a CFS that would simultaneously set climate targets for the agricultural sector and translate them into concrete objectives for farmers is clearly established. Beyond the stated goal of the Commission to make such a scheme a way to diversify land manager's income, it has to be designed to support sustainable transitions of farming systems. This has several implications for its design and its governance. Three aspects in particular need to be addressed: what is the scope and the perimeter of its deployment? How should it be financed? How should its implementation be monitored/followed?

Scope and perimeter: ensuring additionality and avoiding leakages while triggering transitions

The definition of the scope and the perimeter of a CFS has to do with two distinct issues. On the one hand, the scope of implementation should ensure additionality and avoid leakages. CFS are often implemented at the level of practices (e.g. the Australian Carbon Farming Initiative). However, this leads to considerable risks of leakage, meaning that a change in practices leading to an increase in carbon sequestration in soils or reduced emissions can be associated with a parallel change leading to increased emissions. The smallest level at which a CFS could be implemented should therefore be the farm as a whole. A scope 3 approach–meaning that all emissions associated to what the farm purchases to function would be taken into account–could even be preferred. This would in particular enable to capture indirect emissions associated to fertilizer production, a very energy-intensive process whose current emissions amount to roughly 10% of all ag-remated GHG emissions.[15]

On the other hand, the relevant perimeter of a CFS should also go beyond the farm gate. Changes that are within reach for a farmer acting on his own are indeed limited to system optimization or the adoption of "simple" measures such as, for example, cover cropping in arable farming (which can significantly contribute to soil organic carbon sequestration).[16] However, in many cases, a broader system redesign will be required to contribute to climate and biodiversity objectives. This is particularly the case when it comes to re-diversify farming systems and (re)introduce low-inputs crops, such as hemp, legumes, or temporary grasslands. Despite the benefits for the environment but also for farmers, such changes in cropping systems cannot happen in isolation. Farmers need to have access to high quality seeds as well as to buyers and a whole value chain downstream, with collecting agencies, storing facilities and processing units.[17] The deployment of such an integrated approach will require to engage value chain actors, such as interbranch organizations and producer organizations, as well as local governments; they could also play a role of "project aggregator" to reduce transaction costs between projects and funders (see section on finance). Most importantly, the proposed integrated approach is an original way to deal with the problem of non-permanence associated in particular to soil carbon sequestration. It indeed seeks to create "increased returns on adoption" and thus to gradually lock agricultural systems in new states that are favorable to carbon sequestration and emissions reduction. In other words, a CFS will only be effective in the long term if the entire value chain in which a farm is embedded is deeply revamped.

Metrology/evaluation framework: combining CO_2eql and bundles of services

A CFS will need to lean on a robust evaluation framework that will ensure it supports the sort of systemic transition outlined above. Such an evaluation framework thus needs to combine a carbon metric with other key indicators of farming systems transformation. This could take the form of a "bundles of

14 Schader C., Muller A., Scialabba N.E.-H., *et al.* (2015). Impacts of feeding less food-competing feedstuffs to livestock on global food system sustainability. *Journal of The Royal Society Interface*, 12 (113).

15 At the country level, the long-lasting question of carbon leakage refers to whether emission reductions in a given sector could be associated with an increase in import-embodied emissions. While the problem also exists in the agricultural sector, it cannot be dealt with at the level of the CFS.

16 Launay C., Constantin J., Chlebowski F. *et al.* (2021). Estimating the carbon storage potential and greenhouse gas emissions of French arable cropland using high-resolution modeling. *Global Change Biology*, 27 (8), 1645-1661.

17 Meynard J.-M., Jeuffroy M.-H., Le Bail M. *et al.* (2017). Designing coupled innovations for the sustainability transition of agrifood systems. *Agricultural Systems*, 157 (Supplement C), 330-339.

services" approach, encompassing relevant proxies for each crucial dimension on which the scheme has to deliver. The following dimensions would need to be included to fully take into account climate & biodiversity objectives: GHG emissions/ha; level of carbon sequestration in soils and agroecological infrastructures; level of diversification of agroecosystems from plot to landscapes; overall dependency of farming systems on external and synthetic inputs (including animal feed). As mentioned in the Commission's Communication, there will be a clear need for elaborating on existing methodologies (Label Bas-Carbone, Soil Capital, CarboHedge, etc.) to develop an evaluation framework against which to assess projects–*ex-ante, in-itinere and ex-post*. In this work, it is very important that all dimensions identified above are part of the resulting framework. This is likely to be a key challenge, since no existing framework does this satisfactorily.

Financing the transition through a mixed approach

There are at least four types of costs that could be covered by a CFS. Two questions follow the identification of these costs–which this *Policy Brief* does not fully answer: one is whether any priority should be given to one or several of these types of costs; the other one is through which financing mechanisms these costs should be covered.

A first type of costs pertains to the uptake of new practices that are more costly to farmers, but which do not necessarily lead to a systemic transition, such as for example the development of cover crops. In such a situation, the scheme is not in support of a genuine transition, and while this might be of interest it shall not be the priority.

A second type of costs relates to the maintaining of systems that are already highly virtuous from both a climate and biodiversity perspective (i.e. highly diverse, with significant soil carbon stock, and with low level of emissions, such as most organic farms). Financing such costs through a CFS would only be relevant for systems that lack "market recognition".

A third type of costs are those associated to a transition to a new system through the acquisition of new skills/techniques and/or adapted equipment, at the farm level but also beyond (as many changes at the farm level are dependent upon changes occurring elsewhere as mentioned above). Such costs differ greatly from one sector to another and also depend upon the context. Those are the ones a CFS focused on supporting the transition should give priority to.

A fourth and last type are the costs of risk taking associated to any transition. They are different from the third categories in the sense that they are only *potential* costs (it is not because there is a risk that it will be realized)—yet their existence can pose significant challenges to famers willing to kick start a transition.

In our view, the two last types of costs are those to which priority shall be given. In that sense, carbon farming should not be restricted to "a way of diversifying farms' sources of incomes", as the Commmission has put it. Rather, it should be primarily considered as a mechanism to foster systemic and sustainable transitions of farming systems. As such, and now turning to the financial mechanisms through which these costs could be covered, voluntary carbon markets are likely to play only a limited—yet important—role in that process. In particular because the amount it could generate (50-100 €/t$CO_{2\ eql}$) fall well short of what would be needed to foster systemic transitions as outlined in section 1.[18] Another way to direct funds to the transition would be to consider the evaluation framework of the CFS as a *taxonomy*. As such, its objective is to characterize/evaluate the relevance and potential (or actual) performance of a project in a multidimensional approach (including, but not limited to, a carbon/climate perspective) in order to attract public and private finance.

18 As an illustration, the transition costs to re-diversify arable crop rotations and increase the share of leguminous plants are somewhere between 200-250 €/ha/year, while the amount of soil organic carbon such change could sequester would not go beyond 1-1,5t $CO_{2\ eql}$/ha/year, generating at best 100-150 €/ha. See for example Schiavo M. & Aubert P.-M. (2020). *Pour une transition protéique réussie : quelles mesures prendre ?* Iddri.

Aubert, P.-M., Fouchderot, C., Svensson, J., (2022). Design principles of a Carbon Farming Scheme in support of the Farm2Fork & FitFor55 objectives. IDDRI, *Policy Brief* N°01/22.

This work has received financial support from the French government in the framework of the programme "Investissements d'avenir" managed by ANR (French national agency for research) under the reference ANR-10-LABX-14-01. It is co-financed by the LIFE programme of the European Union, under the under the Climate, Infrastructure and Environment Executive Agency (CINEA). This publication only reflects the views of the authors and its sole responsibility lies with IDDRI, I4CE and IFOAM Organics Europe. CINEA is not responsible for any use that may be made of the information provided.

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