Low ILUC-risk certification: Pilot report and recommendations

France, Sequential Cropping, March 2021

Prepared for:

European Commission

Submitted by:

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Reference No.: 210301
ENER/C2/2018-462/LOT 2/SI2.822263
Date: 11 June 2021

Table of Contents

List of Figures

1. Pilot Introduction

1.1 Feedstock and Geography

This pilot tests the low ILUC-risk certification approach for yield increase from sequential cropping for biogas on an arable farm in France.

The pilot project in France was led by consortium member IEEP in close collaboration with Arvalis, a French research institute specialized in arable farming. The Arvalis team bring significant expertise in technical aspects of sequential cropping, as well as contacts of farms implementing sequential cropping in France.

In 2020, Arvalis launched a research project “RECITAL”, focusing on developing guidelines for farmers on sequential cropping in France. The focus of the study is specifically on the performance of energy crops within sequential cropping rotations and aims to optimize cropping rotations which include sequential energy crops. The project aims to gather all research initiatives on sequential cropping across France and to acquire new technical data on the management of these crops within different French regions. Several parameters are being studied including, amongst others, the qualification of the climatic risk, seeding under a vegetative cover, and valorization of the biogas digestate (e.g. soil nitrogen status).

RECITAL runs for the period 2020-2023 which is a similar timeline to the low ILUC pilot project. It is led by Arvalis in partnership with the Association of Biogas Farmers of France (AAMF) as well as the network of Chambers of Agriculture and other economic operators of France. Through the RECITAL research programme, Arvalis is in direct contact with farmers implementing sequential cropping in France.

This low-ILUC pilot is working alongside the RECITAL study and benefits from synergies in terms of the network of farmers and the Arvalis team’s expertise on sequential cropping, to test the concept of a low ILUC-risk certification for farms implementing sequential cropping.

The farm chosen for the Phase 1 pilot is an arable farm located in the Centre-Val de Loire region of France (centre-west of France, see Figure 1)[1]. The farm produces cereals and oilseeds in rotation. It started to implement sequential cropping before the pilot project started. The sequential crop used in this first phase of the pilot is triticale (a cereal), grown over winter.

Figure 1: The pilot farm is located in the Centre-Val de Loire region of France

[1] Initially, three different farms were short-listed for the French pilot. For the purpose of the initial pilot audit, the decision was made to focus on one farm only. The two other farm sites may be involved at a later stage of the pilot project.

The farm chosen for the pilot is part of a group of 14 farms which pool together their resources and machinery and jointly manage their crop production. Together they own and jointly manage 3,500 ha of arable land, of which 400 ha are subject to sequential cropping (95% winter sequential crops, 5% summer sequential crops). This means that the crop cultivation choices, including the type of crops, crop rotation decisions, including where and how much sequential crops to grow, are taken at the level of the farm group, not the individual farm. This particular setting means that more detailed yield and financial data are available than might normally be the case on a typical farm in this region, as farmers in the group need to closely monitor costs and yields for profit re-distribution purposes at the end of the campaign.

In addition, some farms in the group co-invested in a biogas plant which is fed notably with sequential crops grown on the farms. Being involved in biogas production rather than biofuel, the pilot farm is not currently certified under any EC-recognised voluntary scheme.

1.2 Additionality Measures

The additionality measure tested in the French pilot is sequential cropping. Sequential cropping is the practice of planting a second crop in a year on the same plot of land. It is considered an additionality measure because it produces additional biomass from a parcel of land that is already under cultivation, by maximizing the time in which the parcel produces biomass. Typically, sequential crops are grown during winter time[2] and this was the case examined in the French pilot project.

As required by the certification guidance, one specific parcel was selected for the purpose of the pilot audit (see Figure 2). The 'VO70' parcel is 28.44 ha.

The additionality measure was already implemented on the farm and on the selected parcel before the start of the pilot project. The audit was therefore able to test both the setting of the baseline ("baseline audit") and the calculation of additional biomass ("additionality audit").

[2] Growing sequential crops during summer is also possible, although a lot less frequent.

Figure 2: Map of parcel VO70 chosen for the pilot audit

1.3 Audit

The pilot audit was performed on **11 March 2021** by William Rey, an auditor working for Control Union. The audit was performed **onsite** by the local Control Union auditor. The parcel land owner, the crop rotation manager (managing crop rotations on the land of the 14 farms involved in the group) and a researcher from Arvalis were also present.

Initially, three different farms were selected for the French pilot, as travel restrictions have been uncertain during the COVID-19 pandemic. For the purpose of the audit, the decision was made to focus on one farm only where an on-site visit could be organised. The farm chosen, located in Centre-Val de Loire, had the advantage of collecting detailed yield and financial data because of their functioning as a group of farms jointly managing land. It also has a track record of testing sequential cropping methods which has been valuable in understanding decisions a farmer may face in implementing this additionality measure in practice. The two other farm sites, located respectively in Bretagne and in the Bourgogne regions, may be involved at a later stage of the pilot project.

The audit tested the low-ILUC certification on parcel “VO70” in year 2019. The audit tested both the setting of the baseline (“baseline audit”) and the calculation of additional biomass (“additionality audit”).

1.4 Key issues tested

The key issues tested in the French pilot on sequential cropping included:

- **Data availability**. To test whether sufficient historical yield data is available and the degree of granularity (e.g. parcel, whole plantation)
- **Methodology to determine dynamic yield baseline and additional biomass for sequential cropping.** To investigate different units which could be used to compare different crops and calculate a quantity of additional biomass
- **Certification of sequential cropping** that has an impact on the type of crops grown in the crop rotation (how to define the dynamic yield baseline)
- **Additionality test.** To test whether the additionality measures can be demonstrated as additional through a financial attractiveness assessment or a non-financial barrier analysis

Note that the sequential crop is considered to be outside the food and feed cap in the REDII on the basis that it is not the “main crop” (without needing to pass an additionality test). However, the definition of food and feed crops (REDII Article 40(2)) also requires to prove that the sequential crop does not “trigger demand for additional land”. This aspect is considered in this pilot via the approach to determine the additional biomass.

1.5 Relevant documents

Alongside this report, other relevant documents are part of this pilot audit deliverable, as follows:

- Management plan (filled in by Arvalis)
- Audit checklist (Control Union)
- Summary Audit Report (Control Union)
- Financial attractiveness assessment (Control Union based on pilot farmer’s data)
- Map of the selected parcel (pilot farmer)
- Dynamic yield baseline and additional biomass calculation (Arvalis and IEEP)

2. Findings

2.1 Availability of data and evidence

Data was readily available and easy to verify. In France and elsewhere in the EU, the requirements from the Common Agricultural Policy are such that detailed maps, identifying the crops grown at parcel level, are commonly available. Although this varies between Member States, such maps are available in open access in France.

The company had yield data and financial data at a very granular (parcel level), which is due to their functioning as a farm group. This is not typical of farms in this region in France.

2.2 Financial attractiveness assessment

The data for the financial attractiveness assessment are for all 416 ha of sequential crops cultivated in 2019 on the farm group.

The yield and sales figures of the farm groups were well documented and could be verified by the auditor. Yield could be checked at parcel level because, on this specific farm, harvested quantities are linked to specific fields with identification on the transport documents. The sales value figure used is the selling price of the sequential crop to the biogas plant in the year 2019.

Table 1: Financial attractiveness analysis in the French pilot

Financial Attractiveness Analysis

Metric	Value	Unit
Feedstock 1 additional volume	3,045	tonne
Feedstock 1 sales value	120	EUR/tonne
Feedstock 2 additional volume		tonne
Feedstock 2 sales value		EUR/tonne
Feedstock 3 additional volume		tonne
Feedstock 3 sales value		EUR/tonne
Discount rate	3.5%	%
Lifetime	10	years
CAPEX	€ 475,000	EUR
OPEX	€ 234,036	EUR/year
Net Present Value	€ 656,171	EUR
Does the measure pass the Financial Attractiveness test?	YES	
Is the project eligible for low ILUC-risk certification?	NO	

The CAPEX figures relate to investments in agricultural machinery undertaken by the farm group as a whole to implement sequential cropping. This is why the NPV test was carried out on the total sequential crop area on the farm group.

The OPEX figures are known and documented on a per hectare basis. This is a much more detailed level than would normally be expected on a farm in France, and due to joint management of farm work on this farm group.

The NPV calculation is positive which means the project would not pass the financial attractiveness test required for low ILUC certification. The decision to grow sequential crops goes hand in hand with a large-scale investment by some farms within the grouping in a biogas plant. To receive funding from banks, the biogas plant had to be a profitable investment and so there were investments in specific machinery and equipment linked to the cultivation of sequential crops. The logic behind demonstrating a negative NPV to be able to qualify for the low ILUC-risk certification was questioned in the French context.

2.3 Non-financial barrier analysis

Since the financial attractiveness assessment was not passed, in a normal setting, a non-financial barrier analysis should have been attempted. One of the obvious non-financial barriers for the farm seeking the certification would be that it would enable it to access a new market. The piloted farm uses the sequential crop biomass to feed its own biogas plant. The production of biogas is not as closely linked to the restrictions on the use of high ILUC-risk feedstocks as biofuels are. In addition, none of the crops grown on the French farm are currently subject to or at risk of becoming high ILUC-risk feedstocks.

This means that there would be little interest at the moment for a farm like the French pilot farm to seek a certification to access the low ILUC-risk feedstock market. Such certification would not help them to overcome major non-financial barriers.

2.4 Determining the dynamic yield baseline

The calculation model for setting the dynamic yield baseline (DYB) and for the calculation of additional biomass (section 2.5) described in the Phase 1 draft certification guidance led to different possible interpretations when applied in practice.

In this section, we present the different DYB methods which were tested, using varying time periods for the period considered as the baseline. This section presents tables and figures illustrating the main resulting impacts on the DYB. Further calculations and detail are available in the Annex.

In this pilot, introducing sequential cropping required a substantial change in the crop rotation to create a sufficient “time gap” within the rotation to grow the winter sequential crop. In the case of the French pilot farm, a shift was made from the “old” crop rotation system where farmers in the group could flexibly choose to grow either winter or spring crops, to one where the winter sequential crop necessarily has to be followed by a spring crop. This has implications for the definition of the baseline and the calculation of additional biomass.

The campaign chosen for the audit was the year 2019, during which triticale was grown over winter as a sequential crop and harvested in spring 2019, followed by sunflower planted in spring 2019 and grown as the main crop. The following table describes the crop rotation on the selected parcel in the year 2019 and the preceding years.

Table 2. Crop rotation on the selected parcel VO70 of the French pilot farm, 2014-2019

Year	Crop rotation on selected parcel VO70
2014	Winter common wheat
2015	Winter barley
2016	Rapeseed
2017	Winter common wheat
2018	Winter barley
2019	Triticale (sequential crop) + sunflower

Two different approaches were taken for the DYB – methods A and B. Method A has three variants.

Method A uses yields from the selected parcel exclusively - as per the certification guidance - on which crops were grown in rotation (thereby exhibiting very different yields in t/ha). .

Within Method A, we further tested different timescale options (see Table 3):

- Method A1 applied the certification guidance in its simplest interpretation and used the 3 years preceding the introduction of sequential cropping as a baseline. In the French pilot case, this means computing a 3-year average of yields in years 2016-18, with 2019 the year in which the sequential crop was grown. The results are illustrated below.
- Method A2 tries to smooth out the distinctiveness of the yield data obtained in the year with sequential cropping - characterised by a spring oilseed crop being grown as a main crop - by including one year of cereal yield in the calculation. Method 2 compares the 2-year average of 2016 and 2017 (oilseed - cereal) with the 2-year average of 2018 and 2019 (cereal - sequential crop and spring oilseed).
- Method A3 considers that the 'crop rotation cycle' should be seen in its entirety, i.e. a rotation over several years. The introduction of a sequential crop in fact impacts the crop rotation decisions at large, not only on the year it is grown. Method 3 compares what was the 'typical' crop rotation before the introduction of the sequential crop on the farm (cereal – cereal – oilseed) with the equivalent rotation including the sequential crop (cereal – cereal - sequential crop and spring oilseed). Yield data was not available prior to 2014, therefore this method only compares one 3-year crop rotation cycle (2014-2016) as the baseline, with a 3-year crop rotation with the additional measure (2017-2019).

Table 3: DYB and additional biomass results - Method A options (t/ha)

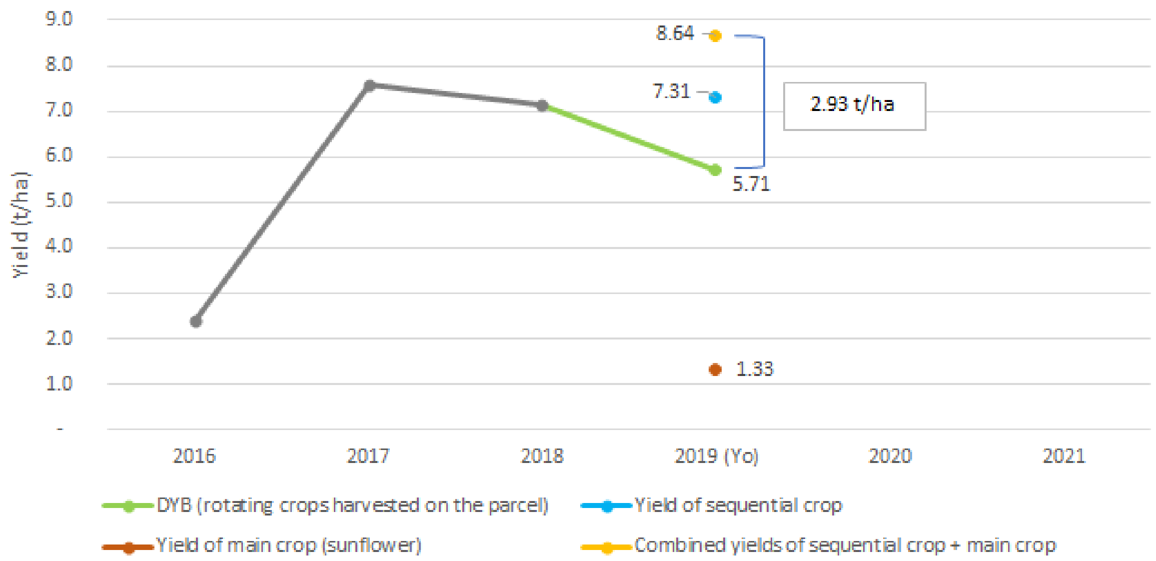
`Metric'	Method A1 2016-18 vs. 2019	Method A2 2016-17 vs 2018-19	Method A3 2014-16 vs 2017-19
DYB reference	5.71	5.00	6.11
Yield in year(s) with sequential cropping	8.64	7.89	7.79
Additional biomass	**2.93**	**2.89**	**1.68**

The cultivation of the sequential crop and the main crop (sunflower) systematically demonstrated additional biomass, for all Method A options. The figures range from 1.68 t/ha

(Method A3) to 2.93 t/ha (Method A1) of additional biomass, which shows the impact of the time periods chosen.

The results of Method A1 are presented in a graph form in Figure 3.

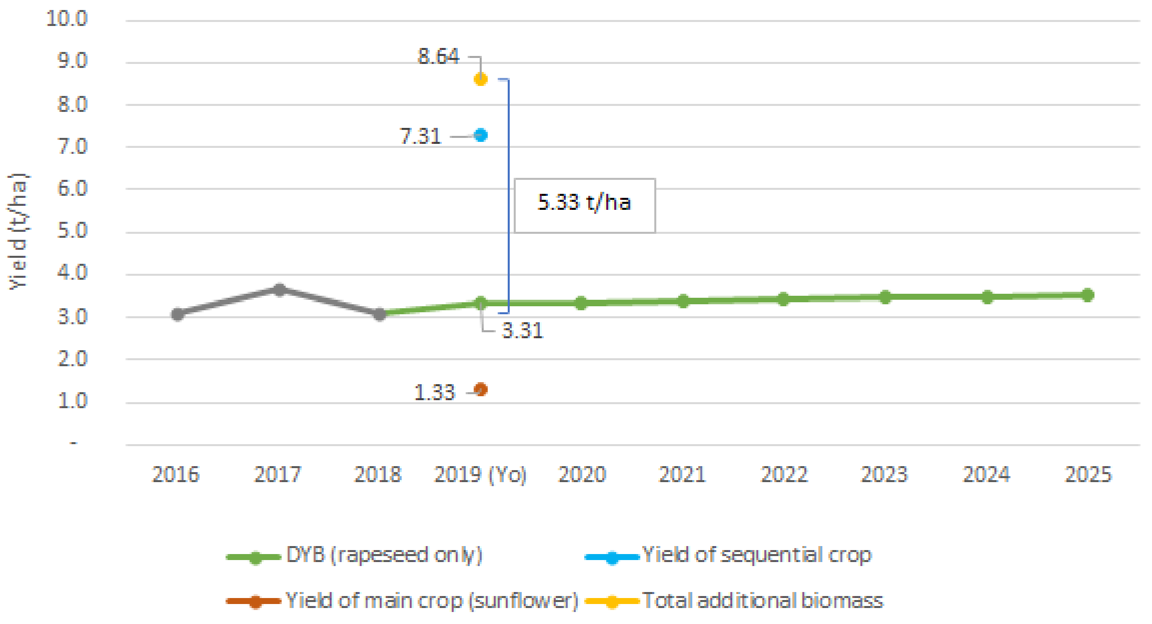
Figure 3: Additional biomass in French pilot with DYB based on rotating crop yields on the selected parcel (Method A1)



Method B proposes a different approach where the DYB is based on a selected crop using whole-farm yields. It is similar to Method A1 in terms of time scale (3-year average 2016-2018 compared to 2019) and thus closely follows the certification guidance document. It however proposes to set the DYB using farm-level yields for rapeseed only, which is the crop being replaced the sequential crop and sunflower, i.e. the rotation shifts from wheat-barley-rapeseed to wheat-barley-sequential crop/sunflower. This requires the DYB to be built on whole-farm level yield data for rapeseed, with yield(s) of the selected parcel. This departs from the certification guidance.

The result shows that 5.33 t/ha of additional biomass was produced in the year tested (2019) (Figure 4).

Figure 4: Additional biomass in French pilot with DYB base on rapeseed yields for the whole farm (Method B)



The difference is significant compared to the Method A results above in which all crops from the rotation are combined. Wheat has the highest yield figure so excluding it lowers the DYB significantly, resulting in more biomass considered 'additional' in Method B.

The two methods differ also in following the requirements of the certification guidance with regard to the **global yield trend** used the slope for the baseline trend.

In Method A, the DYB baseline is built as an average of the crops grown on the selected parcel. These rotate and therefore it was not possible to select one yield increase slope as it was not clear which crop this slope should be based on.

In Method B, the DYB is built on the rapeseed yields and a global yield increase for rapeseed, as provided to in the low ILUC guidance, was used to build the 10 year baseline trend.

Sequential cropping differs from other additionality measures in that it is not necessarily implemented everywhere on the farm. Every year, crops rotate across the agricultural parcels available, with some planted with sequential crops, others not. This means that, every year, a 'counterfactual' is available through parcels on which sequential crops are not grown. In this context, while preparing the management plan for the pilot audit, it appeared artificial to estimate future rapeseed yield data points when the rapeseed yield was actually known for 2019 on the farm. Rapeseed yields should be known in future years too as rapeseed has so far systematically been grown on the farm as part of the crop rotation.

Interestingly, rapeseed in 2019 suffered a particularly bad year and only reached 2.1 t/ha. Had we used the real-life yield rather than the calculated average based on the global trend yield (3.31 t/ha, see Figure 4), the additional biomass that could have been claimed would have been substantially higher.

2.5 Calculation of additional biomass

For the calculation of additional biomass, one prominent issue anticipated for sequential cropping in the guidance is the unit to be used to compare the production of 'biomass' from different crops.

In the previous section, we used the yields expressed in tonnes/ha as a common unit to compare crops[3], i.e. a **weight unit**.

However, technical experts on the pilot project consider that simply comparing tonnes or t/ha produced makes little sense as the crops involved in the rotation examined in France are too diverse (e.g. the yield of wheat is around 7.8 t/ha, whereas that of sunflower is 1.3 t/ha).

Method A options were examined again using two other types of possible units of "yield", as follows:

- **Energy content**. This uses standard energy content values for the crops included in the crop rotation. The question arose as to whether to include the energy contained in the straw, in addition to that of grain. As the whole plant of the sequential crop is harvested, straw energy content of other crops was eventually included as well, to improve comparability.
- **Crop composition approach**. This approach provides a more detailed picture of what the crop yield is composed of, by breaking down the yield into a quantity of proteins, fat, starch and sugar produced, using standard values for each crop. This was thought as another way to enable a comparison of crops with very different characteristics.

Method B was only calculated using weight, in tonnes per ha, and is not discussed further in this section, but it should be noted that deriving Method B's results using other units would have been possible. It is worth noting that rapeseed, which is used to build the DYB in Method B, also happens to be a crop similar to that grown following the sequential crop (sunflower) - which was hoped to ease the comparability issue described above. However, the sequential crop (triticale) included in the yield calculation is a cereal, not an oilseed, so comparability was only improved up to a point.

Calculations with the **energy content** unit, where crop yields are converted in MegaJoules and MegaJoules/ha, show different results than those with weight unit (t/ha) (see section 2.4). With that unit, Method A1, which compares 2019 yields with a DYB based on 2016-2018 yields, fails to demonstrate additional biomass. For the other time scale options (Methods A2 and A3), additional biomass is demonstrated. However, Method A2 and Method A3 results differ by a 3:1 ratio (approximately). These results show both the importance of the unit chosen and the time scale chosen for the DYB and the period with the additionality measure.

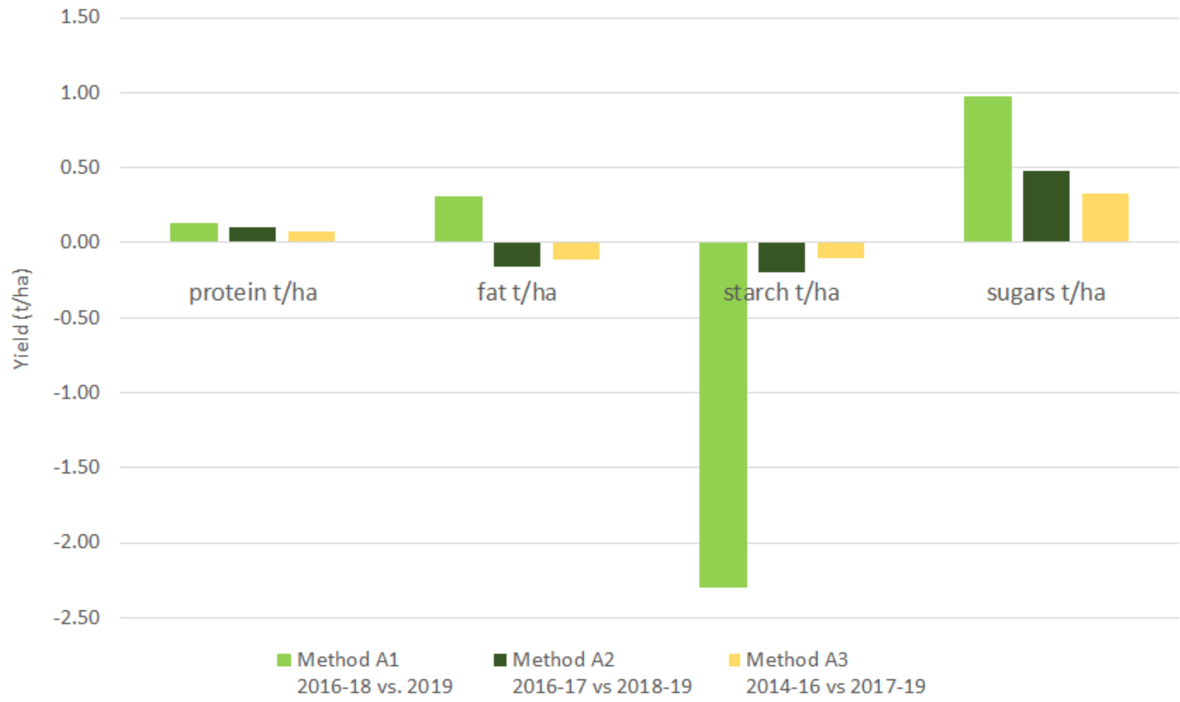
[3] Total volumes in tonnes are also available for Method A

Table 4: DYB and additional biomass results - Method A options, using the energy content approach (in MJ/ha)

Metric	Method A1 2016-18 vs. 2019	Method A2 2016-17 vs 2018-19	Method A3 2014-16 vs 2017-19
DYB reference	200,688	184,243	213,641
Yield in year(s) with sequential cropping	190,731	212,154	223,957
Additional biomass	**- 9,958**	**27,911**	**10,316**

Calculations based on the **crop component approach** aim to give a more detailed examination into the yield of the main macro-nutrients (proteins, fats, starch, sugars) produced by each crop. For all time scale options (Methods A1 to A3), the calculations showed that there were always additional proteins and sugars produced in the years with the sequential crop compared to the DYB (see Figure 5). However, less starch was produced (for all time scales) while quantities of fat were also less with the sequential crop than in the DYB in Methods A2 and A3.

Figure 5: Additional biomass results – Method A options, using the crop component approach



Note: the results are not comparable across macro-nutrient groups and are only presented in a combined graph for visibility. Proteins, fat, starch and sugar results should be read and interpreted separately.

The crop component results strongly depend on the type of sequential crop and main crop grown and those grown during the DYB period. The results appear reasonable in that the production of some macro-nutrients goes up and of others goes down. Technically, the nutrient composition breakdown is probably the most precise approach to compare yields of crops with very different harvest characteristics. However, from the use of this approach, it seems difficult to derive a result that would enable an economic operator to determine an amount of claimable low ILUC-risk additional biomass produced.

Overall, it is clear that the choice of the unit will be a major variable affecting the amount of additional biomass that can be claimed. The use of different units results in figures that cannot be compared (see Table 5), which hampers a numerical analysis of these quantities. However, in principle, using weight has been criticised as not being a robust enough way to compare crops with wide-ranging yields. The nutrient crop composition appears to be a complex unit to choose for the purpose of the audit. The energy content unit may be a valid alternative unit, especially as the aim is to produce biomass that can be used for energy purposes – although in this particular case, the results using this unit would lead to no claimable low ILUC-risk biomass. Other alternative units may need to be explored in the next phase of the project.

Table 5: Comparison of additional biomass calculations using weight, energy content and crop component units (against DYB set using Method A1 2016-18 vs. 2019)

Metric	Weight	Energy	Nutrient crop composition			
Unit	*t/ha*	*MJ/ha*	*t protein/ha*	*t fat/ha*	*t starch/ha*	*t sugar/ha*
Additional biomass	**2.93**	**- 9,958**	**0.13**	**0.30**	**-2.30**	**0.97**

2.6 Sustainability of additionality measure

The pilot farm is not certified to an EC-recognised voluntary scheme. However, the local auditor checked and found that the farm would comply with the REDII core sustainability criteria, if it was to seek certficiation.

Sequential crops have the potential to deliver a number of environmental benefits. In particular, compared to a traditional crop rotation, including sequential crops in a rotation was shown to increase the levels of organic matter in soils thanks to the crop residues and roots remaining in the soils, even though the bulk of the crop is harvested (Perspectives Agricoles, Jan 2020, No 473, pp 51-54). As a result, the carbon stock is increased compared to a rotation with no sequential cropping.

Sequential crops were shown to be effective in catching nitrates and therefore deliver similar environmental benefits to catch crops, namely to reduce nitrate leaching and run-off into water courses, and therefore improve water quality and reduce greenhouse gas (nitrous oxide) emissions from agricultural soils (Perspectives Agricoles, Jan 2020, No 473, pp 42-46).

Through the changes they require in the crop rotation, growing sequential crops also leads to more diverse and longer crop rotations. This in turn provides benefits in terms of biological control of pests, which should in principle enable a reduced use of pesticides.

In the case of the French pilot farm, the sequential crops are fed into the farm’s biogas anaerobic digestor. The digestate from the biogas plant is returned to soils and used as a fertilizer, therefore displacing synthetic fertilizer. Biogas digestate provides nitrogen in a form that is readily available for plants to use, but is highly volatile. If digestates are appropriately applied, in the right conditions, plant growth stage and preferably injected in soils rather than spread, the risks of volatilation and GHG emissions are significantly reduced (Perspectives Agricoles, Jan 2020, No 473, pp 48-50).

3. Conclusions and recommendations for low ILUC-risk methodology

The French pilot audit was successful in that the auditor could check all points on the audit checklist and verify all documents and proof of information/data provided.

The farm did not pass the financial analysis test. The decision to grow sequential crops goes hand in hand with a large-scale investment by some farms within the grouping in a biogas plant. The logic behind demonstrating a negative Net Present Value (NPV) to be able to qualify for the low ILUC-risk certification was seriously questioned in the French context. From a practical business perspective, it does not seem reasonable to expect farmers to undertake an investment that would not be profitable. To receive funding from banks, the biogas plant had to be a profitable investment, as did investments in specific machinery and equipment linked to the cultivation of sequential crops. The financial attractiveness test relies on the additionality measure becoming profitable because of a premium for low ILUC-risk certified biomass. This mechanism has also been questioned in other pilots. However, for feedstocks that are not defined as high ILUC, it is even more in doubt how the existing policy mechanism would lead to a premium for low ILUC-risk certified biomass that would make an otherwise unprofitable investment possible.

The sequential cropping pilot in France shows that the assumptions behind the dynamic yield baseline calculation make a significant difference. As a result, there is no conclusive result on the amount of additional biomass that the pilot farm could claim from the selected parcel.

The time scale used, the type of crops included in the crop rotation (and therefore the crops included in the dynamic yield baseline), the geographical scale of the calculation (parcel only or whole farm yields), and the units used to compare crops all have a substantial impact on the dynamic yield baseline, and therefore on whether or not or how much additional biomass could be claimed as low ILUC-risk. The methodological points tested in this pilot project were the following:

- The time scale for the baseline: which years, and therefore the crops grown, to include in the baseline, when the introduction of sequential cropping led to profound changes in the crop rotation systems.
- The geographical scale: sequential cropping as an additionality measure relies on crop rotations which means that a sequential crop is not grown every year on a same parcel.
- The yield: what should be included in the calculation of yield, both for the baseline and the additional biomass. In particular, should the straw produced by the crop be included, even though in this particular case, it is not harvested and sold but returned to soil instead?
- Yield units: how to compare yields of very different crops – from cereals to oilseeds, to sequential crops (cereals harvested at an immature stage), and potentially to other crops which could be part of the crop rotation such as legumes.

Additional biomass from sequential cropping could be claimed in most – but not all – of the calculation settings. The amount of additional biomass, however, greatly varied depending on the interpretation made on the points above.

Other limitations and questions were fed back during the pilot audit and the preparation of the management plan, which did not cause particular problems in the current pilot, but could well be an issue in other settings:

- There may be a knock-on impact on the second main crop following sequential cropping, e.g. wheat planted following sunflower. This did not occur on the French pilot farm chosen and therefore could not be explored further in the current pilot. The auditor noted "*: if the [yield of the] wheat that follows the sunflower is impacted, should it be included in the calculation. If the harvest of the sunflower is late, the planting of the wheat could be affected and have an impact on the yield of the following year*."
- Unpredictability of crops grown. Even though a crop rotation is intended to follow a certain model, farmers face unpredictable weather conditions and other factors which may lead them to depart from the model and plant other crops. The discrepancy between the model and decisions made in practice can significantly impact the DYB calculation or subsequent additional biomass claim.
- Parcel variability: The fertility of land parcels often varies significantly, even on the same farm in the same year. If the geographical scale chosen for the certification is at the level of the parcel, yield variability between parcels is likely to lead to a wide range of DYB and additional biomass results on the same farm.
- Year-on-year yield variability. Similarly, the variability of yields on the same farm/parcel in different years is subject to many factors, most notably weather conditions, which will significantly affect the setting of the DYB and subsequent additional biomass claims every year.
- Parcel level data: The pilot farm is atypical in that a lot of detailed data was available at parcel level, including exact yield and labour costs at parcel level. The need for such granular level data on the farm arises from its operations being jointly managed within a group of neighbouring farms. Participants in the French pilot considered that typical farms in France are not likely to keep such accurate, verifiable yield data records at parcel level.

Sequential cropping as a low ILUC crop: Given that intermediate and cover crops will be outside the food and feed cap, even without low ILUC certification, the value for those crops of being low ILUC certified is actually questionable, as crops that are not high ILUC do not have any explicit policy benefit from being low ILUC certified, as the policy is currently defined. Intermediate and cover crops will also struggle to meet the financial attractiveness test as the investment required is relatively low compared to the value of the additional biomass volume. In addition, there are open questions regarding the lack of definition for "main crop". In this pilot, the sequential crop was a new crop 'introduced' into the crop rotation – in this case grown in winter – therefore the main crop is considered to be the other crop grown in the same year. The sequential crop is also harvested as the whole plant, at an immature stage, and destined to the biogas plant. However, there may be cases where this may not appear as straightforward. For example, the piloted farm also experiments with 'summer' sequential crops, grown and harvested at the end of the summer, thereby following a similar calendar to the "main crops".

4. Next phase of the pilot

This pilot showed that the audit in itself was straightforward but that the devil has been in the detail of preparing the management plan and methodological questions that arose in this process. The next steps should focus on testing and improving the methodology. Some methodology points that would require clarification and more investigation could include:

- A clear definition of what is the "main crop"
- Explore and reflect on the rationale of the financial attractiveness test, and of alternative uses of the low ILUC certification guidance for those farms which currently do not pass either the financial or the non-financial barrier tests
- Look into more examples of different crop rotations to further test the robustness/ appropriateness of different methodological approaches, using worked examples with other crop rotations and farms
- Explore alternative approaches to the DYB and additional biomass calculations, to demonstrate a low risk of ILUC

Annex: Detailed DYB and additional biomass results

In this annex, we present the various calculation methods that were performed in the French low ILUC pilot project.

Two different approaches were taken for the DYB – methods A and B. Method A has three variants (see section 2.4 for details). The results for both methods A and B are first presented using weight (in tonnes/ha and in tonnes). For Method A, we then present the results of the two alternative units which were also tested: based on energy content and crop composition.

A. Method A – in tonnes per ha and tonnes

Table 6: Yield data for the selected parcel V070, in t/ha

Year	Rapeseed	Common wheat	Winter barley	Sequential crop	Sunflower
2014		8.1			
2015			7.83		
2016	2.4				
2017		7.6			
2018			7.14		
2019				**7.31**	**1.33**

Table 7: DYB and additional biomass results - Method A options (in tonnes/ha)

in tonnes/ha	**DYB and additional biomass - Method A options**		
	Method A1 2016-18 vs. 2019	Method A2 2016-17 vs 2018-19	Method A3 2014-16 vs 2017-19
DYB reference	5.71	5.00	6.11
Yield produced in year(s) with sequential cropping	8.64	7.89	7.79
Additional biomass (in t/ha)	**2.93**	**2.89**	**1.68**

Table 8: Yield data for the selected parcel, in tonnes

Parcel VO70 yield in tonnes	Rapeseed	Common wheat	Winter barley	Sequential crop	Sunflower
2014		236.84			
2015			228.95		
2016	70.18				
2017		222.22			
2018			208.77		
2019				**213.74**	**38.89**

Table 9: DYB and additional biomass results - Method A options (in tonnes)

in tonnes	DYB and additional biomass - Method A options		
	Method A1 2016-18 vs. 2019	Method A2 2016-17 vs 2018-19	Method A3 2014-16 vs 2017-19
DYB reference	167.06	146.20	178.66
Yield produced in year(s) with sequential cropping	252.63	230.70	227.88
Additional biomass (in tonnes)	**85.58**	**84.50**	**49.22**

B. Method B - tonnes per ha

Table 10: Yield data for the selected parcel, in tonnes/ha

Tonnes /ha	Average yields per crop based on all of farm group's lands			Yield for plot VO70	
	Rapeseed	Common wheat	Winter barley	Sequential crop	Sunflower
2014	3.8	7.9	7.7		
2015	3.1	7.8	7.4		
2016	3.1	4.8	5.1		
2017	3.7	7.9	6.6		
2018	3.1	7.0	7.3		
2019	2.1	7.4	7.3	7.3	1.3
2020	2.8	6.9	5.0	6.6	1.7

Table 11: DYB calculation – Method B (in tonnes/ha)

Method B

<u>DYB calculation:</u> 2016-2018 yield for rapeseed only (+slope)
Year of implementation of the additional mesure (=Y0) is 2019.

		2019
Starting point	(=3-year average for rapeseed 2016 to 2018)	3.28
Slope (rapeseed)		0.036
DYB reference		3.31

Table 12: Additional biomass calculation – Method B (in tonnes/ha)

Additional biomass calculation:	Rapeseed is replaced by sequential crop + sunflower

		2019
DYB reference	(Starting point + Slope)	3.31
Yield produced in year(s) with sequential cropping	(sequential crop + sunflower)	8.6
Additional biomass (in tonnes/ha)	(sequential crop + sunflower - DYB reference)	**5.33**

C. Method A - Energy content

Table 13 Energy content standard values used

Standard energy content values per crop	grain/ straw / whole plant	Energy produced by tonne of crop (MJ/t)
Common wheat	grain	15,480
Rapeseed	grain	26,065
Barley	grain	15,620
Sunflower	grain	26,090
Sorghum	grain	16,020
Straw values for straw-producing cereals	straw	16,280
Rapeseed	straw	15,200
Sequential crop	Whole plant (value for tonne of dry matter)	16,920

Grain / straw ratio			
Straw producing cereals	straw =	1.05	x grain
Sunflower	straw =	1.6	x grain
Rapeseed	straw =	1.6	x grain

Table 14: Yield data for the selected parcel, in MJ/ha

Energy content per ha on VO70 parcel (MJ/ha) **Note:** Energy = energy content of grain and straw	Rapeseed	Common wheat	Winter barley	Sequential crop	Sunflower
2014		263,849			
2015			256,151		
2016	120,924				
2017		247,562			
2018			233,578		
2019				**123,685**	**67,045**

Table 15: DYB and additional biomass results - Method A options (in MJ/ha)

in MJ/ha	**DYB and additional biomass - Method A options**		
	Method A1 2016-18 vs. 2019	Method A2 2016-17 vs 2018-19	Method A3 2014-16 vs 2017-19
DYB reference	200,688	184,243	213,641
Yield produced in year(s) with sequential cropping	190,731	212,154	223,957
Additional biomass (in MJ/ha)	**-9,958**	**27,911**	**10,316**

Table 16: Yield data for the selected parcel, in MJ

Energy content of crops on VO70 parcel (MJ)	Rapeseed	Common wheat	Winter barley	Sequential crop	Sunflower
2014		7,714,956			
2015			7,489,844		
2016	3,535,818				
2017		7,238,725			
2018			6,829,820		
2019				**3,616,555**	**1,960,405**

Table 17: DYB and additional biomass results - Method A options (in MJ)

in MJ	DYB and additional biomass - Method A options		
	Method A1 2016-18 vs. 2019	Method A2 2016-17 vs 2018-19	Method A3 2014-16 vs 2017-19
DYB reference	5,868,121	5,387,271	6,246,873
Yield produced in year(s) with sequential cropping	5,576,960	6,203,390	6,548,501
Additional biomass (in MJ)	**-291,161**	**816,119**	**301,629**

D. Method A - Crop composition

Table 18: Crop nutrient composition standard values used

Standard nutrient values per crop	**Grain/ straw / whole plant**	**Gross protein (%)**	**Gross fat (%)**	**Starch (%)**	**Total sugars (%)**
Common wheat	Grain	11.0%	1.4%	57.2%	2.6%
Rapeseed	Grain	18.6%	44.1%	1.5%	5.4%
Barley	Grain	9.9%	1.6%	50.7%	2.2%
Sunflower	Grain	14.8%	44.5%	0.4%	2.5%
Silage barley ~ sequential crop	whole plant	8.1%	1.9%	5.0%	15.0%
Wheat	straw	3.5%	1.3%	0.0%	1.4%

DYB and additional biomass results

Table 19: Yield data for the selected parcel, in t proteins/ha

Protein content produced per ha (t of protein/ha) on parcel VO70	**Rapeseed**	**Common wheat**	**Winter barley**	**Sequential crop**	**Sunflower**
2014		0.89			
2015			0.78		
2016	0.45				
2017		0.84			
2018			0.71		
2019				**0.59**	**0.20**

Table 20: DYB and additional biomass results - Method A options (in t proteins/ha)

in % protein/ha	**DYB and additional biomass - Method A options**		
	Method A1 2016-18 vs. 2019	Method A2 2016-17 vs 2018-19	Method A3 2014-16 vs 2017-19
DYB reference	0.66	0.64	0.70
Yield produced in year(s) with sequential cropping	0.79	0.75	0.78
Additional biomass (in % protein/ha)	**0.13**	**0.11**	**0.07**

Table 21: Yield data for the selected parcel, in t fat/ha

Gross fat content produced per ha (t of fat /ha) on parcel VO70	**Rapeseed**	**Common wheat**	**Winter barley**	**Sequential crop**	**Sunflower**
2014		0.11			
2015			0.13		
2016	1.06				
2017		0.11			
2018			0.11		
2019				**0.14**	**0.59**

Table 22: DYB and additional biomass results - Method A options (in t fat/ha)

t fat /ha	**DYB and additional biomass - Method A options**		
	Method A1 2016-18 vs. 2019	Method A2 2016-17 vs 2018-19	Method A3 2014-16 vs 2017-19
DYB reference	0.43	0.58	0.43
Yield produced in year(s) with sequential cropping	0.73	0.42	0.32
Additional biomass (t fat /ha)	**0.30**	**-0.16**	**-0.12**

Table 23: Yield data for the selected parcel, in t starch/ha

Starch content produced per ha (t of starch/ha) on parcel VO70	Rapeseed	Common wheat	Winter barley	Sequential crop	Sunflower
2014		4.63			
2015			3.97		
2016	0.04				
2017		4.35			
2018			3.62		
2019				**0.37**	**0.01**

Table 24: DYB and additional biomass results - Method A options (in t starch/ha)

t starch/ha	DYB and additional biomass - Method A options		
	Method A1 2016-18 vs. 2019	Method A2 2016-17 vs 2018-19	Method A3 2014-16 vs 2017-19
DYB reference	2.67	2.19	2.88
Yield produced in year(s) with sequential cropping	0.37	2.00	2.78
Additional biomass (t starch /ha)	**-2.30**	**-0.20**	**-0.10**

Table 25: Yield data for the selected parcel, in t sugars/ha

Total soluble sugar content produced per ha (t of sugars /ha) on parcel VO70	Rapeseed	Common wheat	Winter barley	Sequential crop	Sunflower
2014		0.21			
2015			0.17		
2016	0.13				
2017		0.20			
2018			0.16		
2019				**1.10**	**0.03**

Table 26: DYB and additional biomass results - Method A options (in t sugars/ha)

t sugars/ha	DYB and additional biomass - Method A options		
	Method A1 2016-18 vs. 2019	Method A2 2016-17 vs 2018-19	Method A3 2014-16 vs 2017-19
DYB reference	0.16	0.16	0.17
Yield produced in year(s) with sequential cropping	1.13	0.64	0.49
Additional biomass (t sugars /ha)	**0.97**	**0.48**	**0.32**

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