Validation report

Agrolinera

20.08.2024

Validation ID: AGV004

Impact Forecast

Impact Insights & additionality

Contents

Details of the validation process

Timestamps and results:
The validation documented in this report was delivered with the following time stamps and results:

Agrolinera	Validation request	First review	Feedback call	Hand-in revisions	Final review	Wrap-up call
Date	26/07/24 11h32	04/08/24 15h32	13/08/24 10h00	18/08/24 22h00	20/08/24 23h45	
Result	Invalid, positive and significant			Valid, positive and significant		

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Introduction to CIF Validation

To determine the validity of self-assessed climate impact forecasts we provide CIF Validation, which is a third party verification of the calculation of the climate and environmental impact of an innovation, in order to conclude if the Climate Impact Forecast is valid, positive and significant.

Problem solved

There are areas of LCA expertise that can not be covered in the Climate Impact Forecast workshops or CIF Training, for example where domain knowledge and experience are required. With self-assessments there is also a risk of optimism bias. Validation assures that forecasts do not contain gaps, scoping errors, unsupported assumptions or inappropriate data sources. CIF Validations are made on the request of the project team, and possibly commissioned by an impact organisation. The results are used by teams and organisations to compare and communicate the climate impact of projects.

A validation process performed by an impartial impact expert, who has read about the innovation, seen the forecast and used a checklist to assess its validity. The validator provides detailed written feedback and offers the opportunity for a revision. The goal of this process is twofold: increase the quality of a forecast and to conclude if the forecast is suitable to draw conclusions about the positive climate impact of the innovation. This Validation report documents the results of that process.

Definitions of key terminology

Climate Impact Forecast (CIF)	A Climate Impact Forecast or CIF is an LCA based calculation of the GHG reduction or climate adaptation potential of a project. Using our CIF tool, the project team found the net climate impact of the key differences between business as usual and their innovative solution.
CIF Validation process	A review process delivered by a validator and guided by a structured check of the information entered into a CIF, a sensitivity analysis and the write-up of an Impact story. This process usually takes two weeks and includes a first review, a first feedback call between the team and validator, time for revisions if needed, a final review and a final results call.
Validator	Validations are delivered by Validators; CIF trainers with LCA expertise who are trained to perform this process in a uniform and objective way. Other than providing this service, Validators have no relationship with or obligations to the company or supporting organisation requesting the validation, assuring an impartial third party review.
Validation result	The CIF Validation result consists of three independent outcomes, which in the best case are valid, positive and significant. These qualifications and the alternative outcomes are explained on the next page.

The CIF Validation result consists of three independent outcomes

Validity of the forecast

A CIF is valid if it is representative of the project, using appropriate data and well-justified assumptions. Therefore, the CIF and its results are representative of the potential for the project to mitigate, enable or adapt to climate change.

Detailed requirements for validity are specified on www.impact-forecast.com/ CIF-validations. A CIF can be:

Valid	Plausible	Improbable	Invalid

Reduction potential

A CIF is positive when it shows that the project has a lower climate impact than business as usual, or improved climate resilience in the case of adaptation. A positive mitigation or enabler CIF file shows the avoided GHG emissions in -tCO_2eq.

This outcome depends on a sensitivity assessment. CIF results can be:

Positive	Positive within limits	Unclear	Sensitive	Negative

Impact threshold

A CIF is significant when the project has a climate impact (positive or negative) greater than 5 tonnes of CO_2eq per year. This is roughly the global average annual CO_2 emissions per person and the mass of a male African Elephant.

The threshold for significant impact can be set to a higher amount for a particular organisation or occasion. The result can be:

Significant	Marginal

Agrolinera CIF Validation

This validation consists of the following sections

Impact story	An impact story is a summary of how a project makes a positive climate impact. It is written by the validating impact expert and contains the key impact data from the Climate Impact Forecast.
Climate Impact Forecast and Validation result	The Climate Impact Forecast shows the scope and parameters of the impact calculation. This includes the resources used and saved by the innovation, their amount and climate impact, the climate impact per unit of user, and the total climate and environmental impact for all units or users in the timeframe. Validator feedback is included on strong and weak points of the forecast as a whole, as well as the conclusion from the sensitivity assessment and the approval status of individual parameters. The conclusion of the validation process is noted in the Validation result.
Sources and assumptions	The differences (resources used and reduced by the innovation, compared to the baseline solution) and quantities (of materials, energy etc.) in the forecast are based on sources and assumptions specified in this section.

Revolutionising waste management in the traditional dairy industry.

Agrolinera is transforming the dairy sector, through advanced waste management technologies applied to small-scale farms in rural communities. Its systems digitalize the collection of manure and dairy wastewater, streamlining the logistics and keeping their potential to optimise their valorization

How does this make a positive climate impact? Compared to which baseline?

In Europe, traditional dairy farming is still essential in rural communities. In terms of the numbers of cows, traditional farming accounts for about 60% % on average in the EU and up to 90% in some regions for the cow population. Management of manure in such traditional farms requires that the manure is stored in barn pits for long periods before spreading it in the fields regardless of the soil requirements. In the pit, storage conditions cause methane and ammonia emissions due to uncontrolled anaerobic degradation.

Agrolinera´s solutions digitise the collection process of manure, creating a “virtual sewage” from the barn pit to the biogas plant that eliminates the need for storage of the excess manure, avoiding its exposure to the atmosphere, keeping its methanation potential. Minimising this additional storage of manure, reduces the leakage of greenhouse gas emissions and maintains the energy content in the manure for further utilisation, thereby creating a positive impact compared to the baseline.

The impact of Agrolinera’s system is calculated relative to the current scenario where this manure is stored in barn pits until there is enough to be spread or until the fields are ready for fertilising the crops. Instead, the innovation is designed to enable economical delivery to biogas plants where the energy content in the manure is harnessed via anaerobic digestion process.

How much of a climate impact, and what does the impact depend on?

The GHG emission reductions achieved from Agrolinera’s solutions amounts to 5.4 KtCO_2eq. Per year in an average community of 1200 cows. This translates to 204.1 kgCO_2eq per MT of manure collected.

The positive impact is primarily from the saved methane and nitrous oxide that is typically produced by storing of the manure.

The impact is robust, as there are only limited resources consumed to make the technology work.

Validity

The analysis is valid, positive and significant.

Co-benefits

On top of the environmental benefits, the company has a strong social impact as it supports the rural population, enhances farm profitability and adds traceability into an unorganised sector. It also contributes to the digitalization of the traditional farms through blockchain and control via IoT, ensuring efficient and sustainable waste management

Climate Impact Forecast and Validation result

Agrolinera provides digitised collection systems for dairy farm manure surplus collection with a hybrid infrastructure instead of field spreading of this manure. The difference in impact is calculated per year and the total impact of Agrolinera per year is calculated for 26280 times 1 metric ton of manure collected per year.

Validation	By: Amogh Gokhale, Started: Sat Sep 07 2024 14:55:31 CET, Completed: Sat Sep 07 2024 14:58:11 CET
Strong points	One of the most detailed modelling I have seen so far, great effort to make this!!
Sensitivity	The impact is robust, as there is only limited resources consumed to make the technology work. The emission savings from CH4, N20 etc. are based on conservative estimates adding to the robustness.

Production

+	Steel (21% sec = standard mix average) EU h	0.9306 per kg	494.67	g	0.4604
+	Glass fibre	1.24 per kg	23.97	g	0.02972
+	Lead battery cars (39 Wh per kg)	0.8469 per kg	30.44	g	0.02578
+	Electric motor, less than 500 W, estimate	2.706 per kg	38.05	g	0.103
+	Stainless Steel (secondary), average	1.935 per kg	24.73	g	0.04786
+	Computer laptop, 15 inch display	561.3 per p	0.0006088	pcs	0.3417
+	ABS (Acrylonitrile butadiene styrene) chemical	3.402 per kg	7.61	g	0.02589
+	Electric MIG welding 4mm steel, 0.125 kg elec	1.1 per m	57.56	mm	0.06332

Transport

+	Truck+container, 28 tons net (min weight/volur	0.07604 per tkm	100	tkm	7.604
+	Tractor (240 pk)	0.2209 per tkm	2	tkm	0.4419
+	Truck+container, 28 tons net (min weight/volur	0.07604 per tkm	0.28	tkm	0.02129

Use

–	Electricity Spain production	0.07869 per MJ	64.81	kWh	-18.36
+	Electricity Spain consumption	0.07869 per MJ	10	kWh	2.833
+	drinking water europe	0.00063 per kg	13.89	kg	0.00874
–	Agrolinera collection process CH4 savings	94.36 per ton	1	ton	-94.36
–	Avoidance of N2O, CO2 in spreading process	76.1 per ton	1	ton	-76.1
–	Agrolinera collection process N2O savings	18.75 per ton	1	ton	-18.75
–	Diesel B7 including combustion CO2	2858 per m3	3000	cm3	-8.575

Agrolinera's total impact per year

eco-costs of human health euro	unknown
eco-costs of eco-toxicity euro	unknown
eco-costs of resource depletion euro	unknown
eco-costs of carbon footprint euro	unknown

	Carbon footprint CO_2eq.
Impact per 1 metric ton of manure collected per year	-204.1 kg
Impact of 26280 times 1 metric ton of manure collected per year	-5.4Kt

Validation ID: AGV004 Date: 26-08-2024	Agrolinera Mitigation project		Validity of the forecast	Valid
	Impact reduction potential	-204.1 $kgCO_2eq$/ metric ton of manure collected	Reduction potential	Positive
			Impact threshold	Significant

The impact reduction potential is quantified based on a representative dairy community holding a population of 1200 cows and validated at 204,1 kg CO_2 eq. per MT of manure collected.

Sources and assumptions

The differences and quantities in the forecast are based on the following sources and assumptions:

Production

The impact is modelled based on the pilot project of Cabrales (Pilot Unit, PU), which is designed to collect 26,280 Tons of manure per year (FU). To calculate the FU values, we first quantify the Pilot Units and then divide these values by 26,280 Tons to obtain the values corresponding to the FU.

PU:

In the pilot project we have 2 manure transfer systems, collection containers and DPTs (Pit Transfer Equipment, which also implements traceability and monitors to determine the best moment to organize collection). For a community of 1,200 cows (around 20 typical barns of 60 cows) producing 72MT of manure per day (60kg/cow-day of manure) we would need 2 collection containers handling 18 tons of manure each, on a daily collection basis, as per our proprietary design (their average life is 10 years) and 10 DPT systems installed in 10 of the 20 barns.

The description below is an aggregated inventory of the estimated materials required to manufacture the equipment needed to install the system in the functional unit.

1) 2 collection 20ft. containers which will each use a) 2,500kg of steel, b) a 30mm glass fiber tank holding 20m3 of manure weighting 315Kg, c) sensors and electronics (estimated 3pcs), d) 200Kg of valves and pumps, e) 200Kg of stainless-steel piping and f) one 10KWh Lead-Acid battery weighting 400Kg. (to power itinerant containers 24h through battery swapping).

2) 10 DPT systems will each use a) a 6 ft. container steel casing and structure weighting 800Kg, b) 50 Kg of pumps and valves c) 10 Kg of motorized parts d) 1p of sensors and electronics e) 25Kg of stainless-steel pipes, f) an internal plastic body weighting 20K.

In summary, the required hardware for the functional unit will be: 13,000Kg of Steel (2 x 1a (containers)+10 x 2a (DPT), 630Kg of glassfiber (2 x 1 b) , for containers, 800Kg of batteries (2 x 1f) for containers, 1000Kg of mechanical parts formed by valves and pumps and motors (2 x 1d + 10 x 2b + 10 x 2c) which we assimilate to medium sized electric motor, 16 units (2 x 1c + 10 x 2d) of electronics which we can each assimilate to a normal computer laptop, 650Kg of stainless steel piping (2 x 1e + 10 x 2e) for containers and DPTs and 200 Kg of plastic casing for DPTs (10 x 2f), which we assimilate to recycled ABS.

We estimate 138.2m of welding required to assemble container perimeter out of coil and a similar amount to weld structural components. For the DPT, whose container has 48m. welding assembly need we use a similar approximation. Therefore, the total welding required is 138.2*200%*2units (containers)+48*200%*10units (DPT)=1,512.8 meters of welding.

In summary, the production component values in the pilot project (Pilot Unit, PU) and their equivalences per MT of manure (Functional Unit FU) are:

13,000Kg of Steel per PU, corresponding to 494.67gr per FU
630Kg of glass fiber per PU, corresponding to 23.97gr per FU
800Kg of Lead batteries per PU, corresponding to 30.44gr per FU
1,000Kg of Electric motor per PU, corresponding to 38.05gr per FU
650Kg of stainless-steel per PU, corresponding to 24.73gr per FU
16PCs of Computer laptop per PU, corresponding to 0.0006088 per FU
200Kg of ABS per PU, corresponding to 7.61gr per FU
1,512.8 m of welding per PU, corresponding to 57.56mm per FU

Transport

The impact is modelled based on the pilot project of Cabrales (Pilot Unit, PU), which is designed to collect 26,280 Tons of manure per year (FU). To calculate the FU values, we first quantify the Pilot Units and then divide these values by 26,280 Tons to obtain the values corresponding to the FU.

PU:

a) Maximum distance from farm to plant is 50 Km. 1round trip totaling 100Km. It is delivered using a 28tons truck. Therefore, it delivers per year 26,280 MT over 100Km, (2,628,000), which is a cost we need to incur. Manure approx. weight/volume ratio is 1MT/liter, (above 0,41) and is trucked in 28MT net load truck (or higher).

b) The farmer has to deliver the manure to the collection point using its tractor if using containers, which happens 50% of the volume in the Pilot Unit. The maximum distance is 2Km from farm in such cases (4km round trip). Therefore, the Pilot Unit will consume 26,280 * 50% * 4 = 52,560tkm.

c) The containers are itinerant, so we must displace them daily an average of 20km (round trips), so we need to make 365*20=7,300 tkm per year in our Pilot Unit.

In summary, the transport component values in the pilot project (Pilot unit, PU) and their equivalences per MT of manure (Functional unit, FU) are:

2,628,000 tkm transportation in 28tons truck to the biogas plant per PU, corresponding to 100tkm per FU
52,560 tkm transportation in Tractor to collection containers per PU, corresponding to 2tkm per FU
7,300 tkm transportation in 28tons truck for container displacement per PU, corresponding to 0.28tkm per FU

Use

The impact is modelled based on the pilot project of Cabrales (Pilot Unit, PU), which is designed to collect 26,280 Tons of manure per year (FU). To calculate the FU values, we first quantify the Pilot Units and then divide these values by 26,280 Tons to obtain the values corresponding to the FU.

PU:

a) Agrolinera Collection process CH4 savings

With Agrolinera system less methane emission is generated in the barn pit because we implement fast logistics to the digestors. We have different estimates to estimate this impact and used worst case scenario.

Estimate 1 (used) based on IPCC methodology (2006 IPCC Guidelines for National Greenhouse Gas Inventories, chapter 10 -emissions from livestock and manure management), Tier 2 method:

We derive a MCF of 0,28 in table 10.17 because we are considering manure stored for over 1 month in pits under the animals, in Spain which has an average temperature of 15,5 degrees C. Solving for equation 10.23 in this methodology.
EFt= methane emissions per cow = (365*60Kg/cow*7.5%)*(0.24*0.67*0.28 *1)
(21,900*7.5%) *0.045 kg ch4 per cow-year = 1,642kg*0.045=73.91Kg CH4 /cow-year

- 1 cow = 21.9MT manure/year (365*0.06kg/day)
- 3.37Kg CH4/MT manure
- @28 CO2Eq/CH4 =94.36Kg CO2Eq / MT manure

for 26,280 MT/Pilot Unit = 2,479,781 Kg CO2Eq / Year.

Estimate 2 Using Tier 1 methodology:

According to latest informative inventory report from Spanish Government, although manure management is a key source category, it doesn't satisfy the second condition of cattle species being significant since its participation in the source category emissions is below the 25% threshold. Under this premise it is justified to apply Tier 1 method.

According to the Tier 1 methodology, we can derive an EF of 37% (table 10.14)
because we are considering manure stored for over 1 month in pits under the animals, in Spain which has an average temperature of 16 degrees C. Solving for equation 10.23

EFt= methane emissions per cow = (365*60Kg/cow*7.5%) *(0.24*0.67*0.37 *1)
(21,900*7.5%) *0.0595 kg ch4 per cow-year = 1,642kg*0.0595=97.7Kg CH4 /cow-year

- 1 cow = 21.9MT manure/year (365*0.06kg/day)
- 97.7Kg CH4 / 21MTmanure = 4.46Kg CH4/MT manure
- @28 CO2Eq/CH4 =124.88Kg CO2Eq / MT manure

for 26,280 MT/Pilot Unit = 3,281,846 CO2Eq /Year.

Estimate 3. Using the database of the CIF tool, the database does not provide impact figures for uncontrolled degradation in pit, but provides the calculation for an uncontrolled anaerobic degradation of OMSW in a landfill. OMSW has a biogas potential of 100-150 m3/biogas vs. 20-40 m3/biogas of manure. Using averages, we work out a conversion factor of 24% which applied to 26,280 MT of manure yields an equivalent 6,307 MT of OMSW. This yields an impact of 15.4kT of CO2Eq per Pilot Unit.

Specific Sources:

1. 2006 IPCC Guidelines for National Greenhouse Gas Inventories https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_10_Ch10_Livestock.pdf
2. Submission to the sub secretariat of the Geneva convention and EMET programme ("reporting to the European Commission under directive (EU) 2016/2284", 2023 edition) https://www.miteco.gob.es/content/dam/miteco/es/calidad-y-evaluacion-ambiental/temas/sistema-espanol-de-inventario-sei-/es_iir_edicion2023_tcm30-560375.pdf
3. Source data https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/sistema-espanol-de-inventario-sei-/webtabla-inv_tcm30-553008.xlsx
4. Anaerobic Digestion of Biodegradable Organics in Municipal Solid Wastes; by J. Mata-Alvarez, S. Macé, P. Llabres
5. Biogas from Waste and Renewable Resources: An Introduction; by Dieter Deublein and Angelika Steinhauser

Source1 refers to Estimate 1; Sources 2,3 refer to Estimate 2; Sources 4-6 refer to Estimate 2, providing the basis for the average estimates given for the biogas potential of OMSW and cow manure.

b) Agrolinera Collection Process N2O savings

In the pit there is also release of N2O:

Estimate 1 (used): Its CO2eq impact can be derived from source 1 (IPCC methodology) which yields both direct and indirect effects:

Direct impact:	11.71CO2eq. per MT of manure
Indirect impact:	7.04CO2eq per MT of manure
Total impact:	18.75CO2eq per MT of manure

Pilot Unit emissions for this category is 492,750 Kg CO2eq.

We assume an average nitrogen content in dairy cow manure of 5 kg N per MT of manure, a default IPCC factor of 0.005 kg N_2O-N per kg of N, a typical loss as NH3 of 20-40% of the nitrogen in manure. (we use an average value of 30%).

c) Avoidance of N2O, CO2 in spreading process

Besides degradation in the pit, there is aerobic degradation of the manure that happens when spreading it. We assimilate the degradation of manure in the spreading process as composting organic in the database, saving -0.01695 kgCO2.

A more precise and relevant alternative is to account for the GHG emissions of manure aerobic degradation in the spreading process, which is now avoided. These are N2O emissions and CO2. The range figures we have obtained are 0.1-0.3 Kg of N2O and 2-33 Kg of CO2 per MT of manure spread. We assume 0.2Kg and 16.5Kg respectively.

Their CO2Eq is 0.2Kg*298+16.5 = 76.1Kg of CO2eq per MT of manure spread, or 1,999,908 per Pilot Unit.

Data, which is within expectations, was referred in
https://link.springer.com/article/10.1007/s12665-015-5126-8

d) Electricity Spain Production (generation enabled at biogas plant)

The manure is used to produce green energy at a Biogas Plant. (The biogas plant cannot credit them again because it would be double counting their generation, but it is enabled by its collection with our system).

Cow manure has a gasification potential of 20 Nm3/MT, of which typically 65% is methane. Energy of methane is 11.08 kWh/Nm3 and we can assume an electric efficiency generation in the biogas plant of 45%. The electric energy generated by the collected manure is 20 * 65% * 11.08 * 45% = 64.81 kWh/MT of manure, or 1,703,207 kWh per pilot unit of 26,280 MT.

e) Electricity Spain Consumption (energy used by the collection system)

There is a need of electricity to power the systems.

The electric consumption of the system is very limited. We take for simplicity the most energy intensive of the 2 collection methods, which is the container system. This system has a rated power of 25kW, a capacity of 17.5MT and an expected pumping time of 3h per day. It standby consumption is 5kW. Therefore its daily consumption is (25kW*3h)+(5kW*(24h-3h) = 180kWh.

Since this will pump 18MT of manure in the system, the consumption will be 10kWh per MT. For the whole pilot unit, the consumption will be at most 26,280MT*10kWh/MT=262,800 kWh

f) Drinking water Europe (Water usage)

The system uses water to clean the equipment periodically. We estimate an average of 1M3 daily to clean all trucks, transfer systems and containers.

g) The manure managed with our system will not have to be spread. The cost of spreading of this manure in a typical 5,000l (5MT) trucked tank is 10 liters of diesel per hour, (2liters per ton of manure). We must also consider the cost of pumping from the pit which we estimate in 50% of the spreading consumption, totaling 3liters of diesel per ton of manure or 78,840 per pilot unit. We convert this into 78.84 m3.

NOT INCLUDED:

h) Energy used by the cloud data center
We estimate the energy used by cloud-based system to be negligible in our case, for the following reason:

The operation of the system requires IoT data transmission, processing, and storage in the cloud. The IoT captured data is transferred to a cloud-based platform that uses a digital ledger database for keeping track of all transactions.

Although blockchain and digital ledgers are very energy intensive, we estimate this is not relevant in our case, so we are not considering it. Our coach agrees with this assumption.

This is not very relevant because the volumes of data we capture and transfer are not massive (system status data is a vector of less than 30 values with latency of 2 seconds or more) and because only the transactional data (those related to manure transfers and not to the equipment status) get recorded in a blockchain-backed database (less than 10 records per day and device). System status data are recorded on a normal postscript database and deleted on a regular basis.

i) Fertilizer required to replace the manure collected for biogas: We do not include this fertilizer as replacement because our system focuses on the excess of manure generated in dairy farms. Therefore, the crops do not require additional fertilizer to replace the manure.

When the dairy farmer also plants crop and uses the manure as fertilizer, they apply all the manure generated in the barn to the soil, regardless of actual crop or soil needs. The excess of nitrogen dissolved in the manure is not absorbed by the crop or soil and runs off to the rivers and underground water bodies. Therefore, there is no need to replace this excess of manure with mineral fertilizers because the part of manure we are collecting is not used for food production (and instead, degrades aerobically).

In summary, the use component values in the pilot project (PU) and their equivalences per MT of manure (Functional Unit, FU) are:

1,703,207kWh of electric energy saved from the Spanish grid per PU, corresponding to 64.81kWh per FU
262,800kWh of electric energy used from the Spanish grid per PU, corresponding to 10kWh per FU
365tons of water used per PU, corresponding to 13.89Kg per FU
Avoid the emissions of CH_4, CO_2 and N_2O caused by the storage and spreading of 26,280 tons of manure per PU, which are calculated in unit values per FU
Avoid the use and combustion of 78,84m3 of diesel per PU, corresponding to 3,000cm3 per FU.

More information

For more information about this validation, and Climate Impact Forecast Validation in general, reach out to Impact Forecast.

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