

ADEME



Agence de l'Environnement
et de la Maîtrise de l'Energie

INRAE



CARSOLEL, a new tool developed for farmers to account for C sequestration in beef and dairy farms

Hélène Chambaut
Institut de l'Elevage
France, Angers

May 2021



l'institut Agro
agriculture • alimentation • environnement



Breeding cattle brings multi services to society

- Grassland based systems provide services

Maintain air, soil and water quality : e.g. few pesticides use, soil organic matter storage, soil biology

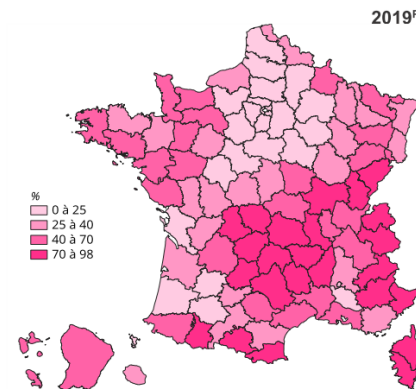
Avoid soil erosion in sloppy region

Enhance biodiversity : diverse flora and fauna, low N inputs, no pesticides

Protect water ressources from nitrate leaching and P runoff

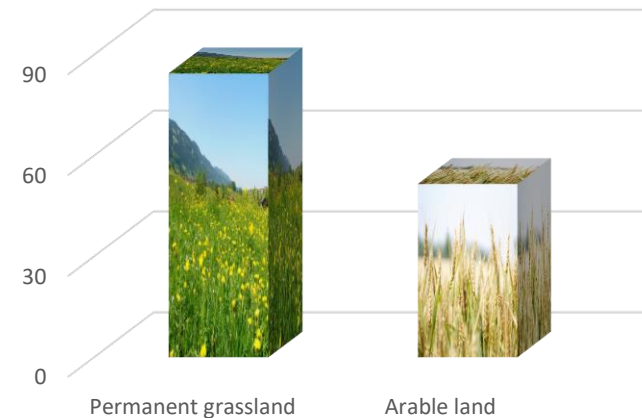
% Grassland area in Agriculture area , 2019

Part des prairies¹ dans la SAU du département
France métropolitaine : 44 %
France : 44 %



1. Prairies artificielles, temporaires et surfaces toujours en herbe.
Source : Agreste - Statistique agricole annuelle

Average Carbon Stock in soil (0-30 cm) TC/HA



Source : RMQS

Climate mitigation options often focus on green house gases emissions (GHG)

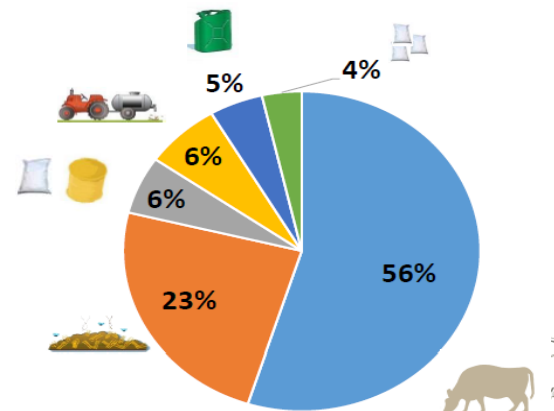
- To decrease carbon emissions per unit product (milk or meat), action plans often encourage an intensification of herd management (e.g. higher daily gain, more milk per cow, shorten age at first calving...) to decrease methane.

More than 50% of GHG emission in French beef farms are CH4



Répartition des émissions

- Fermentation entérique
- Gestion des effluents
- Achats aliments et paille
- Fertilisation
- Energies directes
- Achats d'engrais



J. Andurand et al, 2021
Innovations Agronomiques 82

Accounting for C sequestration in soils is crucial for farm management strategies

- Intensification of herd management often leads to a conversion of grassland into fodder crops
- If grass-based cattle farms are replaced by crop-farming systems, land use management change may results in a loss of carbone in soil

% Grassland in AA from 2010 to 2017

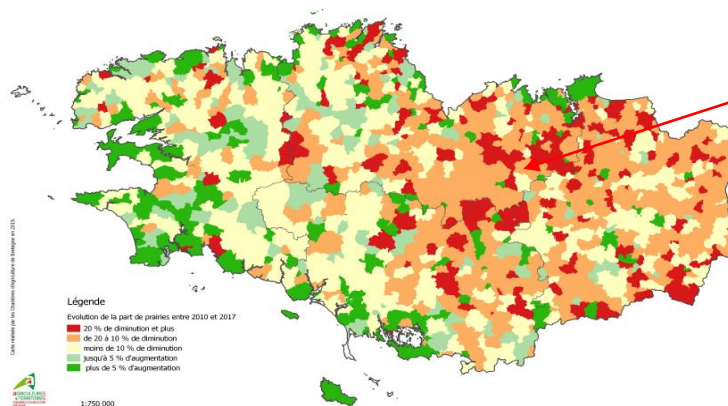
Réduction is

- More than 20%
- 10-20%
- Less than 10%

Increase is

- Less than 10%
- more than 10%

Evolution de la part de SAU cultivée en prairie entre 2010 et 2017
Sources RPG 2010 et 2017 - données ASR



Brittany, ouest of France
reduction of grassland
area in the last 7 years

CAP2ER : both GHG emissions and C sequestration are considered

To exchange with farmer, GHG emission reduction are considered in regards with C sequestration.

C sequestration is a forfait value linked to cover type (grass/crops)

Milk carbon footprint

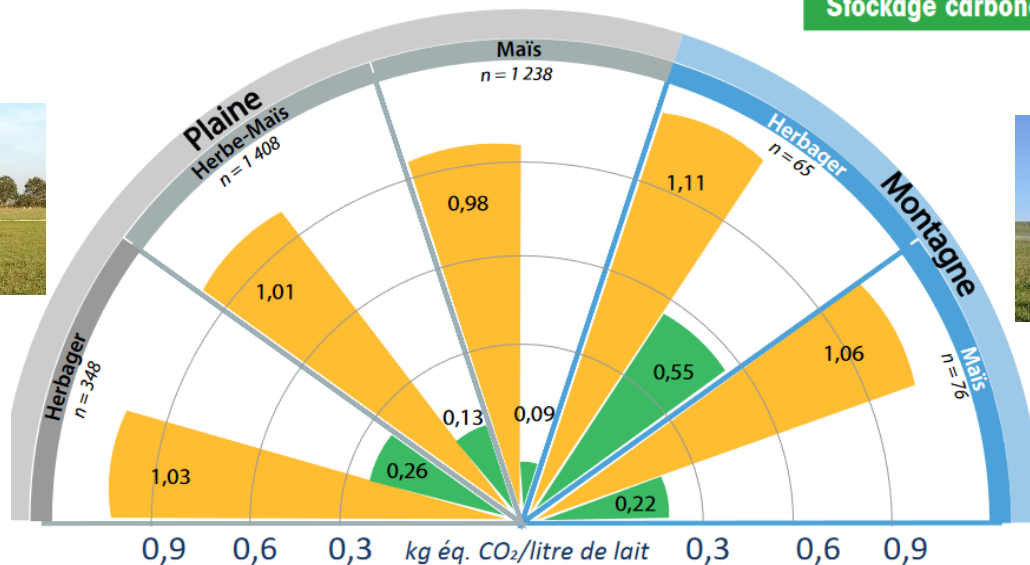
Carbon Dairy, 3 135 farms 2018

Émissions de GES

GHG emitted per kilo milk

Stockage carbone

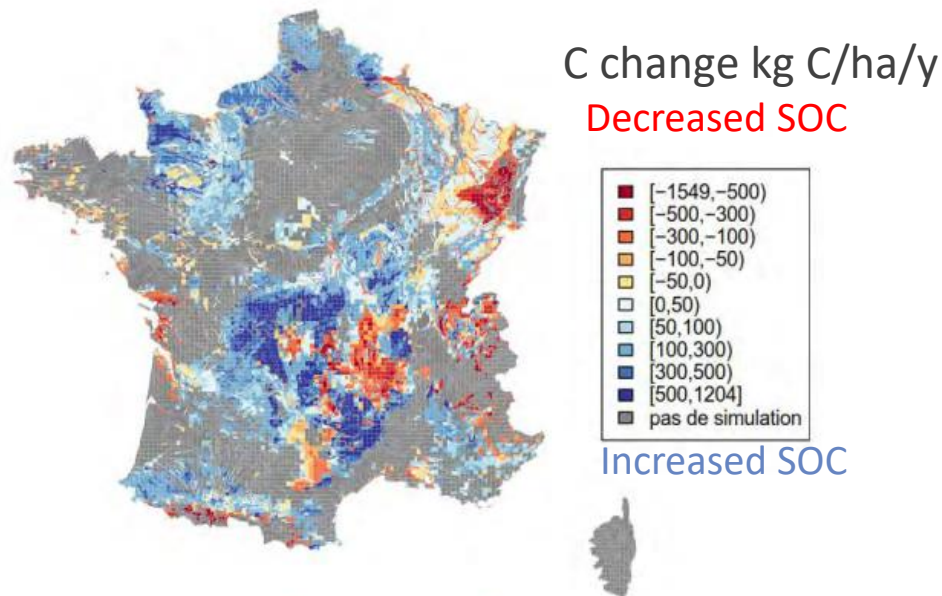
C sequestration : hedges and soil AA



INRAE 4p1000 study precised the C sequestration potential of French grasslands

Analyses show a large variability of C sequestration potential, depending on land use-management- climate and soil conditions => see INRAE- EsCo Pellerin et al. (2020)

Evolution of SOC stock under permanent grassland, when 'business as usual', Pellerin et al., dec. 2020



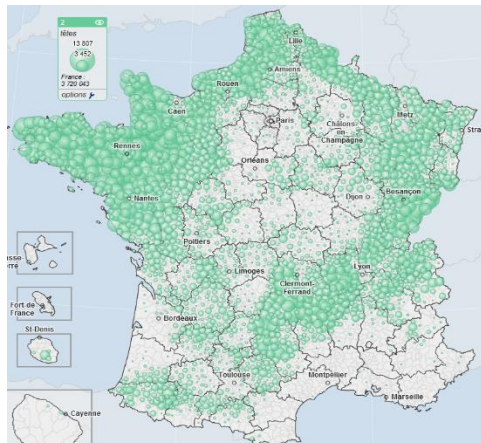
On average, permanent grassland sequester +212 kg C/ha/yr , in a 30 years perspective approach
But there are high variations between and within regions

a. Stockage annuel absolu (kgC/ha/an)

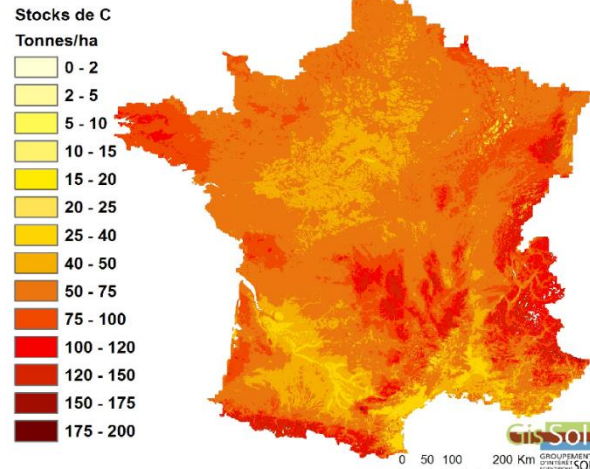
Carsolel project motivation

- Livestock production systems are often located at areas of high soil organic carbon stock.
- To increase SOC at low C areas and prevent from losses at high C areas, tools are needed for advisers and farmers to evaluate effects of agricultural management for livestock production area, including grassland.

Dairy cattle

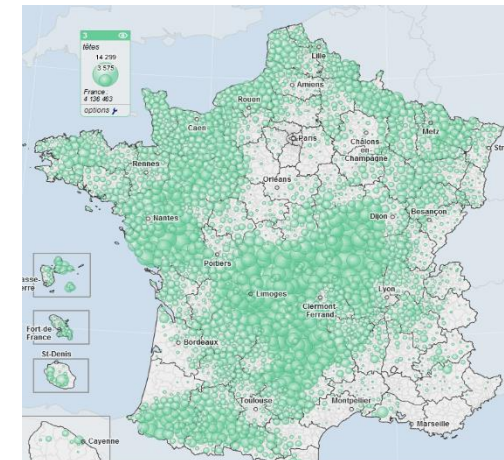


Soil organic carbon stock



Source: Gis Sol, IGCS-PMQS, Inra 2017.

Beef cattle



Carsolel project partners

- Collaboration between **4 INRAE units and Idele** to create and transfer knowledge on soil C sequestration and modelling (Carsolel project **2018-2021**)
- Carsolel **provides a metamodel to predict C sequestration** on field and farm level :

The development of the Metamodel is based on the 500 000 (1km²) simulations by processe based crop and grassland models over France (*4/1000 study ; Pellerin et al., 2020*)

- This projet was funded by ADEME –INTERBEV-CNIEL

Metamodel Carsolel : how does it works?

Metamodele Carsolel estimates average yearly soil organic carbone change in fields

- **Over a period of 30 years**
- **For a given management and soil/climate conditions**
- **Considering top soil : 0-30 cm**

Metamodele Carsolel uses only data available on farm and is fast to run:

- **Step 1 : check soil-climatic context**
- **Step 2 : fill in actual agricultural-management**
- **Step 3 : discuss with farmer new management, fill in forseen management**
- **Step 4 : results « Is the project improving SOC and decreasing GHG? »**

Step 1 : informations to collect

Sélection de la zone et de l'occupation du sol

Vous pouvez choisir une zone ou conserver la France métropolitaine entière. Si vous choisissez de sélectionner une zone, les données pédoclimatiques seront présélectionnées en fonction de cette zone.

Sélectionner une zone à partir d'une carte

Sélectionnez la situation dans laquelle vous êtes :
Prairies permanentes

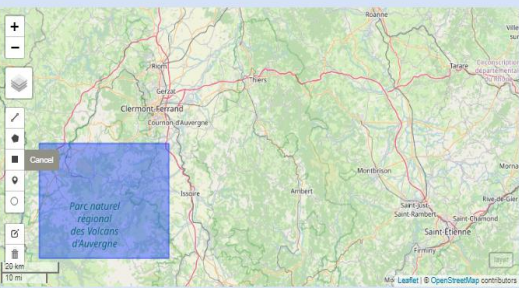
Dans la zone sélectionnée et pour le métamodèle choisi, on a **670 lignes**.

Sélectionner une zone en la dessinant

oui

Vous pouvez masquer la carte de sélection une fois votre zone délimitée

- Masquer les cartes (conseillé pour plus de visibilité une fois la sélection faite)
- Affichage de la carte permettant de sélectionner votre zone
- Affichage des UPC sélectionnés (conseillé pour vérifier la zone sélectionnée)



Distance utilisée pour une zone tampon éventuelle. Laissez 0 si vous ne souhaitez pas ajouter de zone tampon.

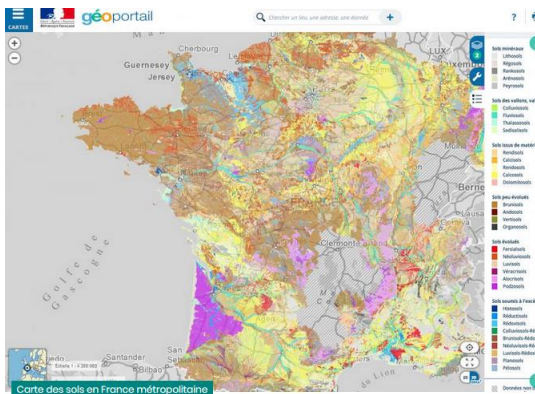
Where is the farm located ?

Carsolel considers average rainfall and temperature of climate zone. Value can be adapted by user if needed (e.g. mountain region)

Soil analysis available on farm?

Fill in Carsolel data file on

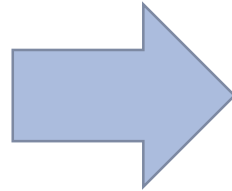
- soil depth, gravel content,
- soil texture, % clay and sand,
- carbonate, pH,
- Organic matter content



<https://www.geoportail.gouv.fr/donnees/carte-des-sols>

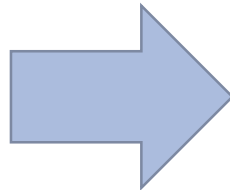
Step 2 : actual situation

Fill in actual management for a group of fields on similar soil type :



Management

- Number of Grazing periods over a year, LSU/Ha
- Number of cut/year, overall yield
- Fertilisation application : organic and mineral.
- N fixation



Grass-Leys

- Years in crops and in temporary grassland
- Mineral and organic fertilisation
- Frequency of cover crop
- Irrigation (yes/no)
- + information on grass management

Step 3: Discuss results with farmer define/simulate new options

If non spreadable area. E.g.

- **In Crop rotation** : Increase frequency of cover crops, insert a Fodder-crops as luzerne
- **In Grass-ley rotation** : Increase of life time of sown grasslands in the rotation

If spreadable area:

Replace mineral fertiliser by manure application

Adapt grass management

- Decrease grazing stocking load on very intensive paddocks close to stable
- increase elsewhere by extension of pathways and fence
- Graze mown field if possible



! ?

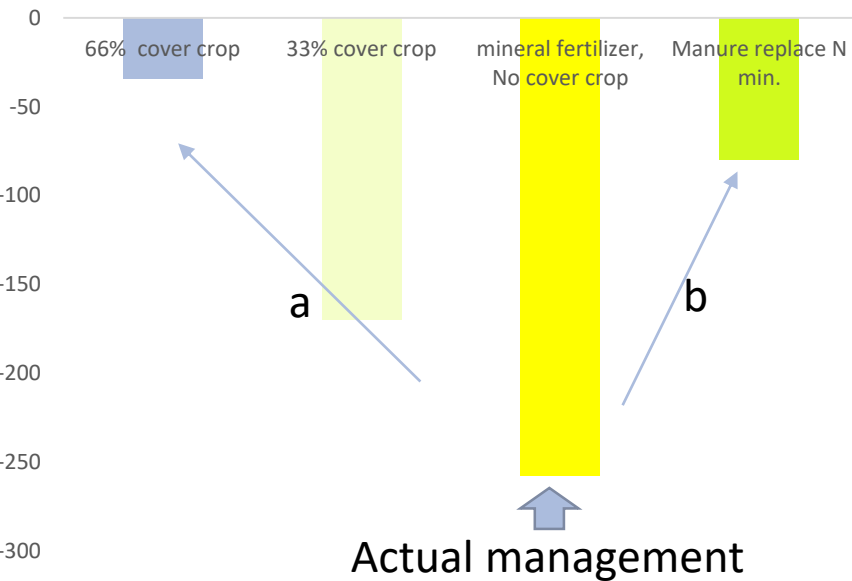
So, many options to combine and test at farm level to increase SOC

Step 4 : Compare options to define best management options at farm level

- Carsolel results for a farm located west of France

Cropping systems : loss of C

Change in carbone stock 0-30 cm (kg C/ha/year)

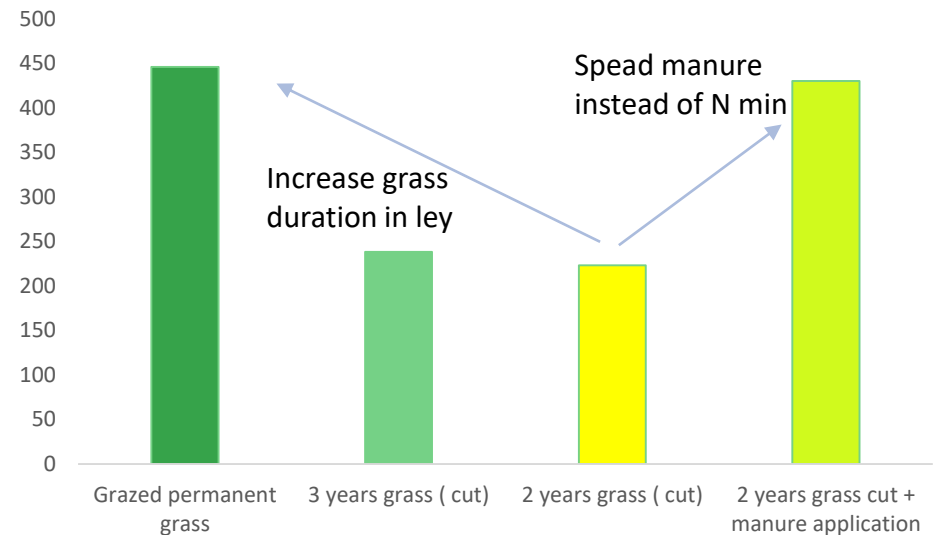


Actual management

- a- non spreadable field, effect of increasing cover crop*
- b manure allowed : effect of replacement N min by org. manure*

Grassland Leys : Gain in C soil

Change in carbon stock 0-30 cm , Kg C/ha/year



Actual management

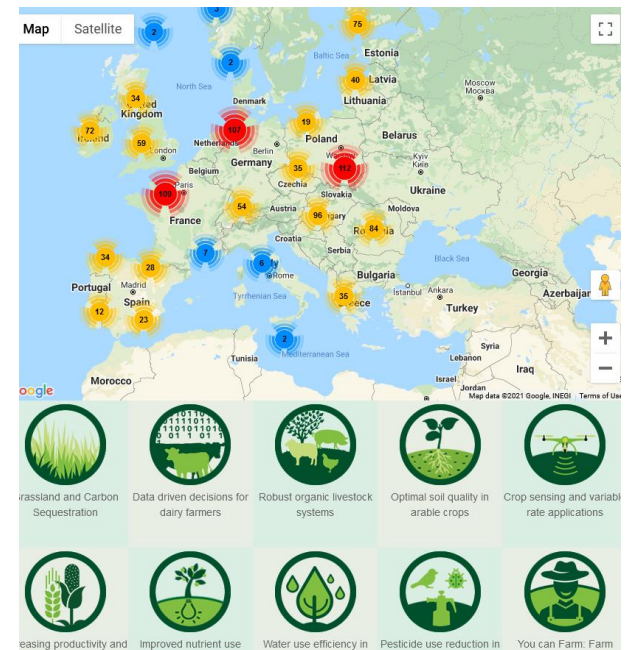
Metamodel Carsolel field test : farmers appreciate

Prototype V0 was tested by French farmers and advisors in Nefertiti Hub, beef carbon and dairy in 2020

=> Refinement in 2021

=> Ready to start in 2022

Nefertiti is an EU networking of demo farmers, ready to test new option



<https://nefertiti-h2020.eu>

Reliability of CarSOLEL ?

Carsolel is a statistical approach (randome forest)

based 1km² simulation with Stics (crop) and PaSim (grass) model (Pellerin et al.,2020)

built using 80% of dataset and validate on the 20% remaining

Prediction error on the validation dataset :

Kg C / ha et / an	0-30 cm	Soil profile (Total)
Permanent grassland (PaSim)	48	68
Ley-arable : annual crop and temporary GL (Stics)	41	78
Only cash crops (Stics)	50	60

$$= \sqrt{\frac{(\text{valeur prédite par le métamodèle} - \text{valeur prédite par stics ou pasim})^2}{\text{nb de données}}}$$

Who can use CarSolEl ?

If you want to be informed when an open access is launch online, please send an email to project coordinator helene.chambaut@idele.fr

- the model is built on french pedo-climatic context.
- **It covers most common french soils**, nevertheless it can't be used on some soils : wet soil, organic soils, recently drained soil are excluded for instance
- If your soil-climatic conditions do fit into the validated conditions, simulations can be achived

Main contributors:

K.Klumpp



Al Graux



F.Vertès



O.Théron



A.Chabbi



L.Brun-Lafleur



H.Chambaut



Carbon agri
advisors

Other links: to design climate action plans at farm level: Idele and partnership activities in France

Have an overall view of farm performance : on climate, water quality, air, biodiversity with CAP2ER

Free online access to calculate carbon foot print in beef and dairy cattle farm, sheep or goat production

<http://idele.fr/services/outils/cap2er.html>



Other links: to design climate action plans at farm level: Idele and partnership activities in France

- Optimise the use of manure on farm : 80 ressources classified in 3 issues

<http://gestion-effluents-dejections.idele.fr>

- ✓ **Regulation implementation** : european and French obligations
- ✓ **Farm building** : how much manure is produced, which slurry pit is request, digestate composition, ...
- ✓ **Spreading** : composition of manure, quantity to be spread, how and when...



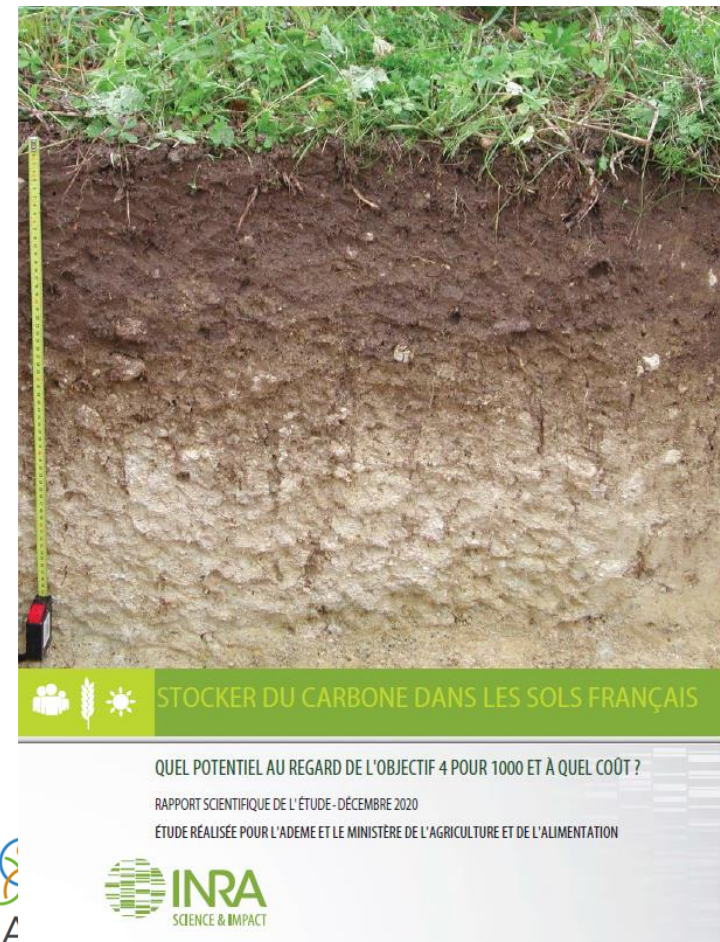
Other link: to design climate action plan in farm : INRAE 4p1000 study

- National study on C sequestration potential of French agricultural land

<https://www.inrae.fr/en/news/storing-4-1000-carbon-soils-potential-france>

The INRA study first identified the farming and forestry practices that favour soil C storage and are compatible with agroecology.

Using agronomic and economic modelling, it was possible to simulate the effects of these practices on the evolution of storage over a 30-year period. An original methodology was deployed, using km² by km² estimates to evaluate the **additional storage** contributed by each new practice compared to changes in C storage if no appropriate measures were implemented.



Other link : to design climate action plan in farm : Idele and partnership activities in France

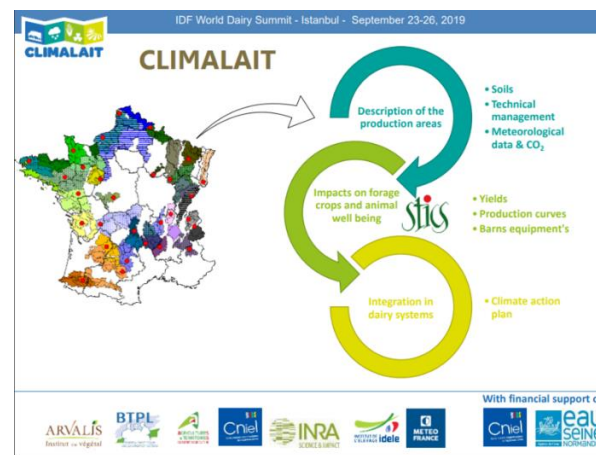
How climate change will affect farming systems management if no mitigation option was adopted : a way to motivate farmers for C sequestration and GHG réduction



What is the Life LiveAdapt Project?

LIFE LiveAdapt is part of the LIFE programme of the European Union, in which a multidisciplinary team of entities from Spain, Portugal and France will identify and assess, for four years (2018-2022), solutions for the adaptation to climate change of extensive livestock production models in southern Europe.

http://idele.fr/no_cache/recherche/publication/idelesolr/recommends/adaptation-au-changement-climatique-et-gestion-des-aleas-temoignages-deleveurs.html



http://idele.fr/no_cache/recherche/publication/idelesolr/recommends/how-to-address-mitigation-and-adaptation-to-climate-change-in-the-dairy-sector-to-improve-its-global.html

Other link: to design climate action plan in farm : Idele and partnership activities in France

- Hedges, agroforestry and wood on farmland to increase C seq.in soil : encourage farmers to use woody chips as litter is a good way to increase C seq. back to agriculture field area

FOCUS R&D

ARBELE
L'ARBre dans les exploitations d'ÉLEVage herbivore



Bien utiliser la litière plaquette dans mon élevage
Comment faire les bons choix ?

OBJECTIFS

- Aider au renforcement de l'autonomie de l'exploitation en utilisant une ressource en bois disponible sur l'exploitation et dont l'entretien régulier permet de récupérer un produit valorisable et substituable à la paille.
- Proposer un protocole efficace de mise en place de litière plaquettes au sein de différents systèmes : aires d'exercices, aires paillées, râteliers extérieurs et aires extérieures.

La plaquette utilisée en litière : un moyen méconnu de bien valoriser le bois
La ressource bois d'une exploitation permet de produire du bois d'œuvre (forêt), du bois bûche (bocage et forêt) et du bois de faible valeur (menu bois et bois tendre (vergnés, saules, peupliers). En pratiquant une gestion durable de l'ensemble, il est possible de créer de la plus-value notamment sur bois de faible valeur en produisant de la plaquette utilisable en litière.

Rappel d'un itinéraire technique simplifié pour la production de plaquettes

- Coupe des bois du 1^{er} août au 31 mars. Attention lors de la coupe, assurez-vous de la pérennité de la biomasse disponible ; n'hésitez pas à vous faire aider par la Chambre d'Agriculture (il est possible de réaliser une évaluation de la biomasse et se former sur la gestion durable auprès de la Mission Haies Auvergne).
- Déchiquetage (privilégier les déchiqueteuses à couteaux).
- Séchage en tas de 3 m de haut minimum (si possible en intérieur pendant 4 à 6 mois. Le taux d'humidité ne doit pas dépasser 25 % pour que la litière absorbe bien les jus). Attention, si le tas a mal séché, le taux d'humidité des plaquettes peut être de 40-50 %, auquel cas la durée d'absorption de la litière sera divisée par deux.

La mécanisation de ces étapes a fortement évolué. De nouveaux outils permettent de moderniser la récolte des bois. Ils permettent de gagner du temps et de travailler en sécurité. Ils sont à envisager sous forme collective, type CUMA.



Fine couche comme antidérapant
(Source : S. Monier, Mission Haies Auvergne Rhône-Alpes)



<http://idele.fr/reseaux-et-partenariats/aclimel/publication/idelesolr/recommandations/bien-utiliser-la-litiere-plaquette-dans-mon-elevage.html>

Other link: to design climate action plan in farm : Idele and partnership activities in France

Farmers association in carbon credit label

<https://www.france-carbon-agri.fr/>

France
CARBON AGRI
Association

Accueil L'Association ▾ S'engager ▾ La méthode Les projets Contact

Vous souhaitez vous engager avec France CARBON AGRI Association pour

- Réduire vos émissions et stocker du CO2

Plus d'infos
- Accompagner les agriculteurs dans leurs démarches et valoriser votre travail

Plus d'infos
- Soutenir les efforts de réductions et compenser vos émissions de CO2

Plus d'infos



Thank you for your attention

