On the link between climate change *mitigation* and *adaptation* in dairy cow farming in West of France

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With financial support from :

Presentation outline

How does the carbon footprint of dairy farming evolve when adaptating to climate change in western France ?

- Context : dairy farms in West of France
  - Need for adaptation
  - Need for mitigation
- Method:
  - To co-design adaptation pathways with farmers : forage rummy®
  - To evaluate carbon footprint: CAP2'ER ®
- Results
- Discussion
- Conclusion

Context
French west dairy farms facing climate change

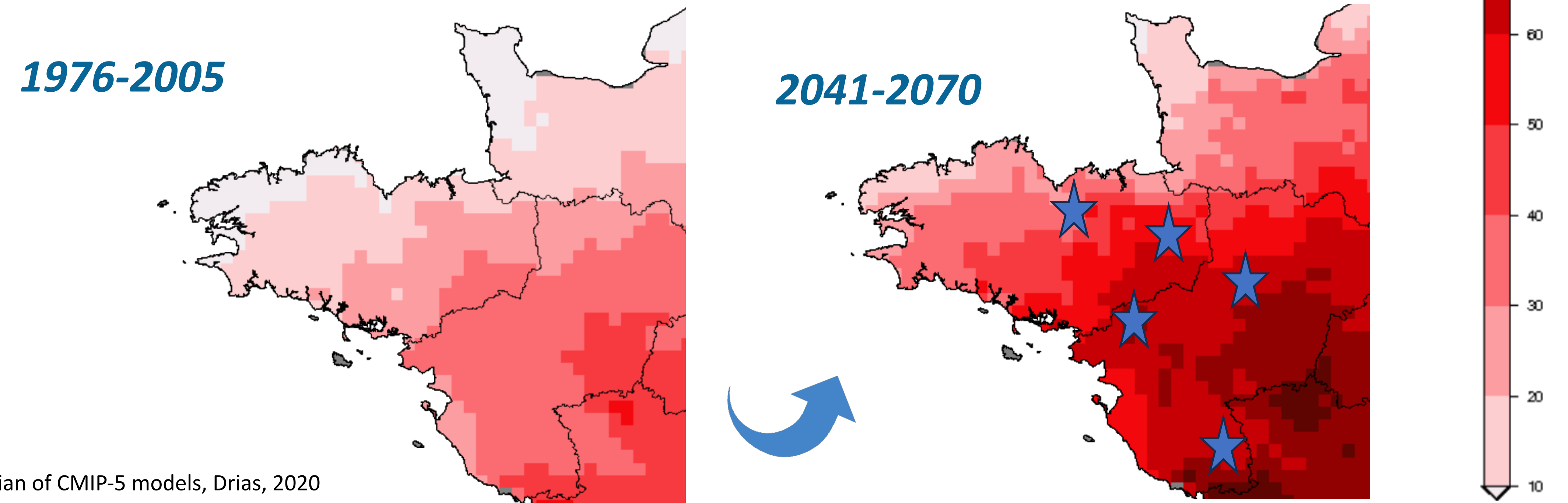
	MILK DELIVERED (MILLION T)	PART OF THE NATIONAL PRODUCTION	NB OF DAIRY COWS	NB OF DAIRY FARMS	AVERAGE COWS/FARM	AVERAGE MILK PRODUCTION/COW (KG/YEAR)	AVERAGE CONCENTRATES/COW (KG/YEAR)	STOCKING RATE (LSU/HA)
Brittany	5.37	23%	693 590	9 900	72	7 969	1 000	1.5
Pays de la Loire	3.73	16%	501 164	6 900	71	7 230	1 250	1.35

≈40%

Idele, 2022

➔ Fodder systems mainly based on a grass and maize association
➔ Drought years are becoming more frequent: 2003-2011-2019-2020-2022

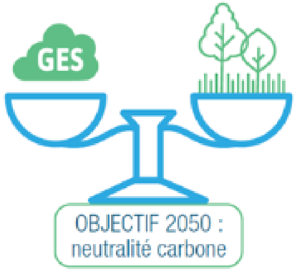
<u>Number of days with high temperatures (Tmax >25°C) :</u>



Median of CMIP-5 models, Drias, 2020

Context
At the same time: dairy farms need to mitigate their GHG:

French Government's
National strategy (SNBC)



Goal by activity sector for 2030 (compared to 2015)
Objectifs sectoriels de diminution d'ici **2030** *par rapport à 2015*

Transports	Building	Industry	Energy production	Waste	Agriculture
-28%	-49%	-35%	-33%	-37%	-18%

Goal by activity sector for 2050 (compared to 2015)
Objectifs sectoriels de diminution d'ici **2050** *par rapport à 2015*

Transports	Building	Industry	Energy production	Waste	Agriculture
Décarbonation complete (à l'exception du transport aérien domestique)	Décarbonation complète	- 81%	Décarbonation complète	- 66%	- 46%

Objectif émissions totales = 80 MtCO2eq

Dairy sector

Goal 2025 :

CO_2

-17%
Milk carbon footprint

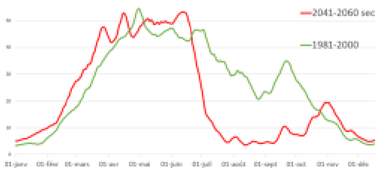
-15%
Dairy plan exit

-20%
Farm exit

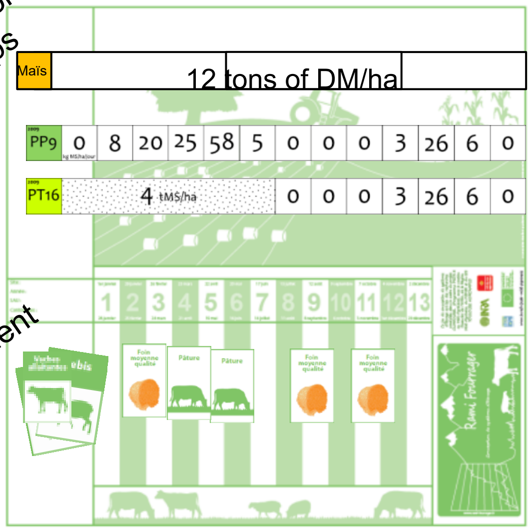
Method:
Co-design of adaptation pathways: Forage Rummy®

(Based on Martin, G. et al 2011)

CMIP-5 – RCP8.5
CNRM-Aladin63

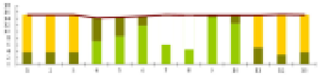


Production of forage and crops



Herd management

Model



Animal needs (INRA, 2007) + stocks

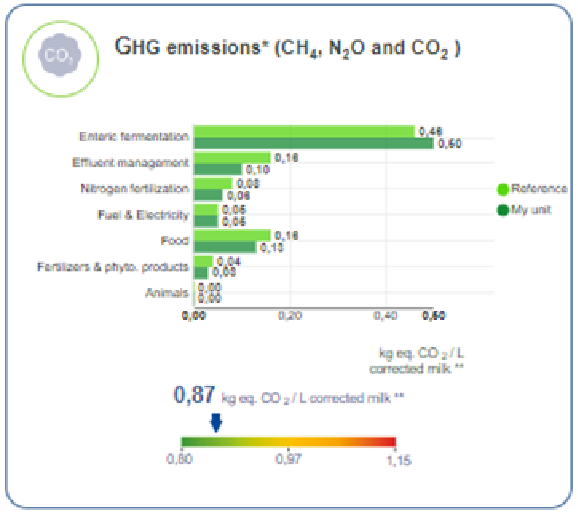
Does the new system consume more fuel ?
Does the new system emit more GHG ?

Method
CAP'2ER level 1 – Method and limits

- CAP'2ER
  - LCA method
  - Environmental analysis : GHG, air and water quality, energy consumption
  - Positives contributions : carbon sequestration, conservation of biodiversity, food performance
  - Results with comparison to references
- CAP'2ER Level 1
  - A simplified analysis
  - Dairy / Beef cattle boundaries (with the forage area)
  - 35 activity data / 1 hour to collect data and to present results to farmers
  - To develop an observatory
  - To highlight the link between practices and environment
  - Carbon storage is estimated based on Dollé et al. (2012):
    - Temporary grassland is set at 80 kg C/ha/year
    - Permanent grassland is set at 570 kg C/ha/year
    - Hedgerows are set at 125 kg C/100linear meters/year
- Limits
  - Purchased fodder is not considered
  - Average value for concentrate and mineral fertilizer
  - Nitrogen excreted is fixed by animal category
  - Manure management method are defined by default

CAP'2ER®

(Moreau, S. et al 2017)



From Forage Rummy ➔ CAP'2ER

Mécaflash

- Most of the required data are present in RAMI simulation + default values based CAP'2ER database
- Estimation of fuel consumption through the Mecaflash tool based of references from CUMA "Cooperative of Users of Agricultural Machinery"

Results

	Pays de la Loire	Brittany
Localisation - label		
System at start :		
Selected and integrated adaptation levers :		
Change of density in LSU/ha of forage area		
Milk production :		
Fuel consumption in l/ha :		
GHG emission in kg CO_2-eq/corr. l. milk:		
C sequestration in kg CO_2-eq/corr. l. milk:		
Main driving factors in carbon footprint reduction:		
Cost of fodder system in €/1000l		

Results

Pays de la Loire

Brittany

Localisation - label	Loire-Atlantique - organic
System at start :	146ha inc. 21ha of a cereal and protein crops mix **17% of maize** 94 dairy cows at 7000l
Selected and integrated adaptation levers :	**Multispecies** leys, silage of a **cereal-and-protein-crops mix as relay cropping,** reduction of **renewal rate,** earlier **age at 1st calving**
Change of density in LSU/ha of forage area	
Milk production :	
Fuel consumption in l/ha :	
GHG emission in kg CO_2-eq/corr. l. milk:	
C sequestration in kg CO_2-eq/corr. l. milk:	
Main driving factors in carbon footprint reduction:	
Cost of fodder system in €/1000l	

Results

Pays de la Loire

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Change of density in LSU/ha of forage area	1,2 ➔ 1,1
Milk production :	Same
Fuel consumption in l/ha :	85 ➔ 91 **+7%**
GHG emission in kg CO_2-eq/corr. l. milk:	
C sequestration in kg CO_2-eq/corr. l. milk:	
Main driving factors in carbon footprint reduction:	
Cost of fodder system in €/1000l	

Results

Pays de la Loire

Brittany

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Change of density in LSU/ha of forage area	1,2 → 1,1
Milk production :	Same
Fuel consumption in l/ha :	85 → 91 **+7%**
GHG emission in kg CO_2-eq/corr. l. milk:	0,93→0,90 **-3%**
C sequestration in kg CO_2-eq/corr. l. milk:	0,11→0,11
Main driving factors in carbon footprint reduction:	Lower age at 1st calving and renewal rate, (but more fuel)
Cost of fodder system in €/1000l	

Results

Pays de la Loire

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GHG emission in kg CO_2-eq/corr. l. milk:	0,93➔0,90 **-3%**
C sequestration in kg CO_2-eq/corr. l. milk:	0,11➔0,11
Main driving factors in carbon footprint reduction:	Lover age at 1st calving and renewal rate, (but more fuel)
Cost of fodder system in €/1000l	272€➔ 285€

Results

Pays de la Loire

Brittany

Localisation - label	**Loire-Atlantique - organic**	**South-Mayenne - organic**
System at start :	146ha inc. 21ha of a cereal and protein crops mix **17% of maize** 94 dairy cows at 7000l	89 ha inc. 9ha of a cereal and protein crops mix **100% grass** 62 dairy cows at 5000l
Selected and integrated adaptation levers :	**Multispecies** leys, silage of a **cereal-and-protein-crops mix as relay cropping,** reduction of **renewal rate,** earlier **age at 1st calving**	**Group calving** in autumn, silage of a **cereal-and-protein-crops mix as relay cropping, more grazing** in early spring
Change of density in LSU/ha of forage area	1,2 → 1,1	
Milk production :	Same	
Fuel consumption in l/ha :	85 → 91 **+7%**	
GHG emission in kg CO_2-eq/corr. l. milk:	0,93→0,90 **-3%**	
C sequestration in kg CO_2-eq/corr. l. milk:	0,11→0,11	
Main driving factors in carbon footprint reduction:	Lover age at 1st calving and renewal rate, (but more fuel)	
Cost of fodder system in €/1000l	272€→ 285€	

Results

Pays de la Loire

Brittany

Localisation - label	**Loire-Atlantique - organic**	**South-Mayenne - organic**
System at start :	146ha inc. 21ha of a cereal and protein crops mix **17% of maize** 94 dairy cows at 7000l	89 ha inc. 9ha of a cereal and protein crops mix **100% grass** 62 dairy cows at 5000l
Selected and integrated adaptation levers :	**Multispecies** leys, silage of a **cereal-and-protein-crops mix as relay cropping,** reduction of **renewal rate,** earlier **age at 1st calving**	**Group calving** in autumn, silage of a **cereal-and-protein-crops mix as relay cropping, more grazing** in early spring
Change of density in LSU/ha of forage area	1,2 → 1,1	1,2 → 1,0
Milk production :	Same	Same
Fuel consumption in l/ha :	85 → 91 **+7%**	81 → 84 **+3,5%**
GHG emission in kg CO_2-eq/corr. l. milk:	0,93→0,90 **-3%**	1,02 → 0,99 **-3%**
C sequestration in kg CO_2-eq/corr. l. milk:	0,11→0,11	0,19 → 0,19
Main driving factors in carbon footprint reduction:	Lover age at 1st calving and renewal rate, (but more fuel)	Lower age at 1st calving (but more purchase of concentrates)
Cost of fodder system in €/1000l	272€→ 285€	

Results

Pays de la Loire

Brittany

Localisation - label	Loire-Atlantique - organic	South-Mayenne - organic
System at start :	146ha inc. 21ha of a cereal and protein crops mix **17% of maize** 94 dairy cows at 7000l	89 ha inc. 9ha of a cereal and protein crops mix **100% grass** 62 dairy cows at 5000l
Selected and integrated adaptation levers :	**Multispecies** leys, silage of a **cereal-and-protein-crops mix as relay cropping,** reduction of **renewal rate,** earlier **age at 1st calving**	**Group calving** in autumn, silage of a **cereal-and-protein-crops mix as relay cropping, more grazing** in early spring
Change of density in LSU/ha of forage area	1,2 → 1,1	1,2 → 1,0
Milk production :	Same	Same
Fuel consumption in l/ha :	85 → 91 **+7%**	81 → 84 **+3,5%**
GHG emission in kg CO_2-eq/corr. l. milk:	0,93→0,90 **-3%**	1,02 → 0,99 **-3%**
C sequestration in kg CO_2-eq/corr. l. milk:	0,11→0,11	0,19 → 0,19
Main driving factors in carbon footprint reduction:	Lover age at 1st calving and renewal rate, (but more fuel)	Lower age at 1st calving (but more purchase of concentrates)
Cost of fodder system in €/1000l	272€→ 285€	196€ →220€

Results

Pays de la Loire | **Brittany**

Localisation - label	**Loire-Atlantique - organic**	**South-Mayenne - organic**	**East-Vendée**
System at start :	146ha inc. 21ha of a cereal and protein crops mix **17% of maize** 94 dairy cows at 7000l	89 ha inc. 9ha of a cereal and protein crops mix **100% grass** 62 dairy cows at 5000l	91ha inc. 26 ha of wheat **40% of maize** 73 dairy cows at 8000l
Selected and integrated adaptation levers :	**Multispecies** leys, silage of a **cereal-and-protein-crops mix as relay cropping,** reduction of **renewal rate,** earlier **age at 1^{st} calving**	**Group calving** in autumn, silage of a **cereal-and-protein-crops mix as relay cropping, more grazing** in early spring	**Multispecies** leys, silage of a **cereal-and-protein-crops mix , more grazing, less wheat**
Change of density in LSU/ha of forage area	1,2 → 1,1	1,2 → 1,0	1,9 → 1,5
Milk production :	Same	Same	Same
Fuel consumption in l/ha :	85 → 91 **+7%**	81 → 84 **+3,5%**	125 → 117 -6%
GHG emission in kg CO_2-eq/corr. l. milk:	0,93→0,90 **-3%**	1,02 → 0,99 **-3%**	1,07→0,91 **-15%**
C sequestration in kg CO_2-eq/corr. l. milk:	0,11→0,11	0,19 → 0,19	0,05→0,06 **+2%**
Main driving factors in carbon footprint reduction:	Lover age at 1^{st} calving and renewal rate, (but more fuel)	Lower age at 1^{st} calving (but more purchase of concentrates)	More grazing, less purchase of soybean cakes, less fuel
Cost of fodder system in €/1000l	272€→ 285€	196€ →220€	223€ → 215€

Results

	Pays de la Loire			Brittany
Localisation - label	**Loire-Atlantique - organic**	**South-Mayenne - organic**	**East-Vendée**	**East-Ille-et-Vilaine**
System at start :	146ha inc. 21ha of a cereal and protein crops mix **17% of maize** 94 dairy cows at 7000l	89 ha inc. 9ha of a cereal and protein crops mix **100% grass** 62 dairy cows at 5000l	91ha inc. 26 ha of wheat **40% of maize** 73 dairy cows at 8000l	45ha inc. 10ha of triticale partly auto-consumed **18% of maize** 34 dairy cows at 6000l
Selected and integrated adaptation levers :	**Multispecies** leys, silage of a **cereal-and-protein-crops mix as relay cropping,** reduction of **renewal rate,** earlier **age at 1st calving**	**Group calving** in autumn, silage of a **cereal-and-protein-crops mix as relay cropping, more grazing** in early spring	**Multispecies** leys, silage of a **cereal-and-protein-crops mix** , **more grazing**, **less wheat**	Reduction of **renewal rate,** earlier **age at 1st calving,** less triticale, **lucerne**, **multispecies** leys , less maize
Change of density in LSU/ha of forage area	1,2 → 1,1	1,2 → 1,0	1,9 → 1,5	1,45 →1,15
Milk production :	Same	Same	Same	Same
Fuel consumption in l/ha :	85 → 91 **+7%**	81 → 84 **+3,5%**	125 → 117 -6%	95 →95 **0 %**
GHG emission in kg CO_2-eq/corr. l. milk:	0,93→0,90 **-3%**	1,02 → 0,99 **-3%**	1,07→0,91 **-15%**	1,10 → 0,98 **-11%**
C sequestration in kg CO_2-eq/corr. l. milk:	0,11→0,11	0,19 → 0,19	0,05→0,06 **+2%**	0,18→ 0,21 **+16%**
Main driving factors in carbon footprint reduction:	Lover age at 1st calving and renewal rate, (but more fuel)	Lower age at 1st calving (but more purchase of concentrates)	More grazing, less purchase of soybean cakes, less fuel	Reduction of age at 1st calving and renewal rate, Shift from soybean cake to rapeseed cake, less fertilisation
Cost of fodder system in €/1000l	272€→ 285€	196€ →220€	223€ → 215€	201€ → 215€

Results

Localisation - label	Pays de la Loire: Loire-Atlantique - organic	Pays de la Loire: South-Mayenne - organic	Pays de la Loire: East-Vendée	Brittany: East-Ille-et-Vilaine	Brittany: East-Côtes d'Armor
System at start :	146ha inc. 21ha of a cereal and protein crops mix **17% of maize** 94 dairy cows at 7000l	89 ha inc. 9ha of a cereal and protein crops mix **100% grass** 62 dairy cows at 5000l	91ha inc. 26 ha of wheat **40% of maize** 73 dairy cows at 8000l	45ha inc. 10ha of triticale partly auto-consumed **18% of maize** 34 dairy cows at 6000l	80ha inc. 10ha of wheat partly auto-consumed **14% of maize** 60 dairy cows at 6000l
Selected and integrated adaptation levers :	**Multispecies** leys, silage of a **cereal-and-protein-crops mix as relay cropping,** reduction of **renewal rate,** earlier **age at 1st calving**	**Group calving** in autumn, silage of a **cereal-and-protein-crops mix as relay cropping, more grazing** in early spring	**Multispecies** leys, silage of a **cereal-and-protein-crops mix** , **more grazing**, **less wheat**	Reduction of **renewal rate,** earlier **age at 1st calving,** less triticale, **lucerne**, **multispecies** leys , less maize	**No more wheat**, forage **beetroot**, **lucerne**, **multispecies** leys
Change of density in LSU/ha of forage area	1,2 ➔ 1,1	1,2 ➔ 1,0	1,9 ➔ 1,5	1,45 ➔1,15	1,4 ➔ 1,2
Milk production :	Same	Same	Same	Same	Same
Fuel consumption in l/ha :	85 ➔ 91 **+7%**	81 ➔ 84 **+3,5%**	125 ➔ 117 -6%	95 ➔95 **0 %**	94 ➔ 86 **-9 %**
GHG emission in kg CO_2-eq/corr. l. milk:	0,93➔0,90 **-3%**	1,02 ➔ 0,99 **-3%**	1,07➔0,91 **-15%**	1,10 ➔ 0,98 **-11%**	1,11 ➔ 1,04 **-6%**
C sequestration in kg CO_2-eq/corr. l. milk:	0,11➔0,11	0,19 ➔ 0,19	0,05➔0,06 **+2%**	0,18➔ 0,21 **+16%**	0,16 ➔ 0,16
Main driving factors in carbon footprint reduction:	Lover age at 1st calving and renewal rate, (but more fuel)	Lower age at 1st calving (but more purchase of concentrates)	More grazing, less purchase of soybean cakes, less fuel	Reduction of age at 1st calving and renewal rate, Shift from soybean cake to rapeseed cake, less fertilisation	Less protein purchase of soybean cakes, no more wheat p° , more temporary grasslands
Cost of fodder system in €/1000l	272€➔ 285€	196€ ➔220€	223€ ➔ 215€	201€ ➔ 215€	199€ ➔ 200€

Discussions

- Model approach with results that depend on **hypothesis and approximations**
- Strong interest for farmers : an **operational approach** to **include stakeholders**
- Big focus on milk production – cereals and meat outputs used as a buffer ➔ challenge the methodology to compare GHG over the **same farm outputs**
- We are comparing a current situation to an ideal adapted system. What about transition years ?
  - Climate change also implies in the short-term fodder or concentrate deficit, reduction of animals and milk production, ploughing and reseeding grasslands

To conclude

- Observed **synergy between adaptation and mitigation**
- Looking for **adaptation goes through the optimisation of farming practices**, which in turn favors the carbon footprint of the system
  - reduce waste and use of inputs, limit the number of unproductive animals, diversify grassland so less need for N fertilisation, increase share of auto-produced proteins
- Farmers were satisfied with results: see a win a win and are already putting in to place these practices. But, they noticed the **potential increase of workload by diversifying forages**

Thank you for your attention

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