

Latest public research on forage and turf and update on CLIMAGIE

Jean-Louis Durand, Lina Qadir Ahmed, Thierry Bariac, Romain Barillot, Philippe Barre, José Luis Blanco-Pastor, Didier Combes, Abraham Escobar-Gutierrez, Lucas Faverjon, Ela Frak, et al.

▶ To cite this version:

Jean-Louis Durand, Lina Qadir Ahmed, Thierry Bariac, Romain Barillot, Philippe Barre, et al.. Latest public research on forage and turf and update on CLIMAGIE. ISF World Seed Congress 2019, Jun 2019, Nice, France. 37 diapos. hal-02789481

HAL Id: hal-02789481 https://hal.inrae.fr/hal-02789481

Submitted on 5 Jun 2020

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers. L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - NonCommercial - NoDerivatives 4.0 International License

Latest public research on forage and turf and update on CLIMAGIE

Jean-Louis Durand, Lina Ahmed, Thierry Bariac, Romain Barillot, Philippe Barre, Jose Luis Blanco Pastor, Didier Combes, Abraham Escobar, Lucas Faverjon, Ela Frak, Marc Ghesquière, Wagdi Ghaleb, Camille Gréard, Bernadette Julier, Thomas Keep, Isabelle Litrico, Gaëtan Louarn, Julien Meilhac, Vincent Migault, Catherine Picon-Cochard, Marie-Pascale Prudhomme, Simon Rouet, Jean-Paul Sampoux, Serge Zaka, Florence Volaire.

INRA Research units: UR P³F, UREP, EVA, CEFE

INRA Research divisions : Plant Biology and Breeding, Environment and Agronomy, Ecology of Forests, Grasslands and Waters



Nice 5 June 2019



INRA

for sown grasslands improvement

- 4 laboratories (Lusignan, Montpellier, Caen, Clermont Ferrand)
- 50 permanent staff, 40 more temporary →equivalent to private sector (GNIS 2019)
- Pluridisciplinary : Plant Ecophysiology, Ecology, Genetics and breeding
- Open science
- CLIMAGIE: Adapt grasslands to climate change: breeding and ecological intensification. <u>http://www6.inra.fr/climagie</u>



- I. The importance of sown grasslands in France
- II. Adapt grasslands to climate change
- III. The challenge of breeding for multi-species grasslands
- IV. Conclusions

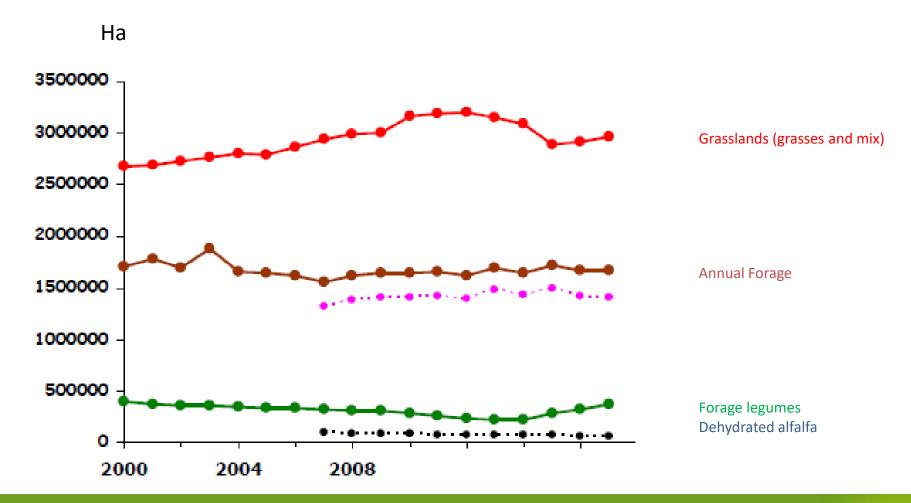


I. The importance of sown grasslands in France

- II. Adapt grasslands to climate change
- III. The challenge of breeding for multi-species grasslands
- IV. Conclusions

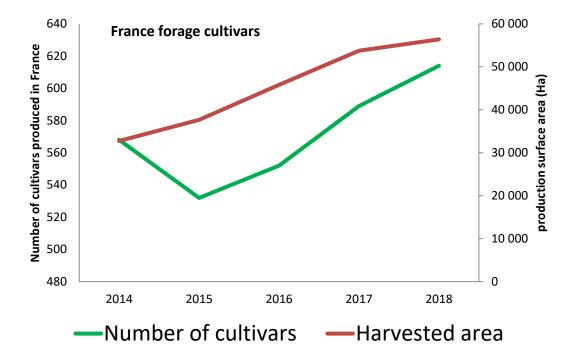


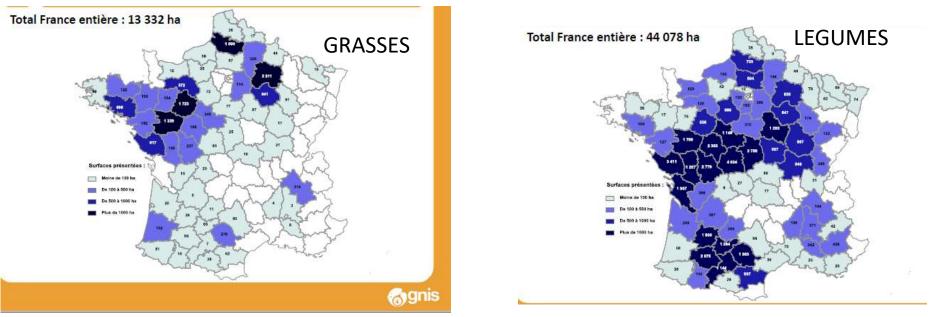
Sown grasslands are a crucial component of agricultural systems in France

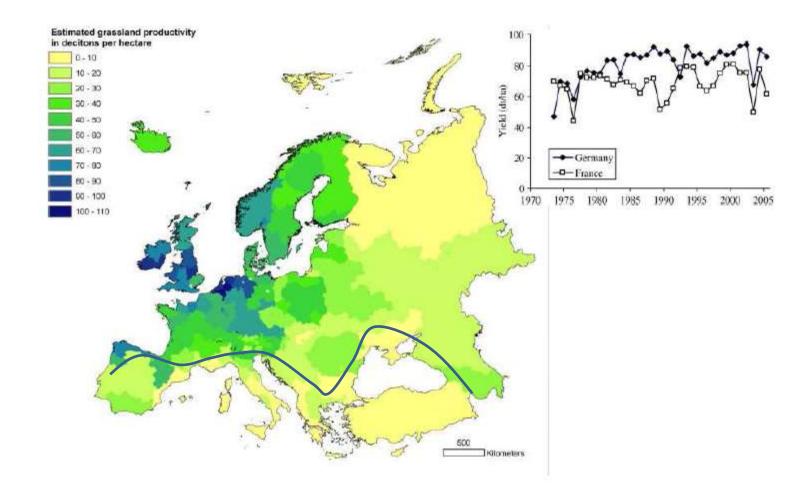




Grass and legume seeds production in FRANCE







Stat nationales 1995-2004. in Smit, Metzger & Ewert, 2008. EJA



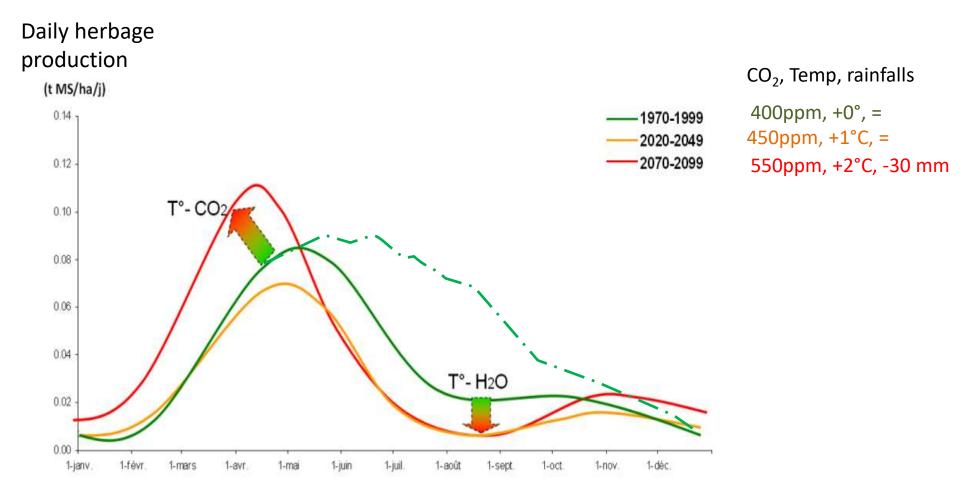
I. The importance of sown grasslands in France

- II. Adapt grasslands to climate change
- III. The challenge of breeding for multi-species grasslands

IV. Conclusions

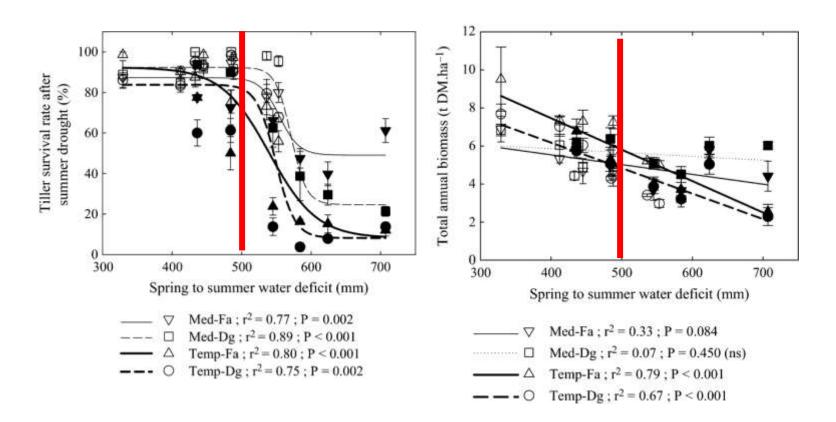


Impact of climate change on grassland productivity



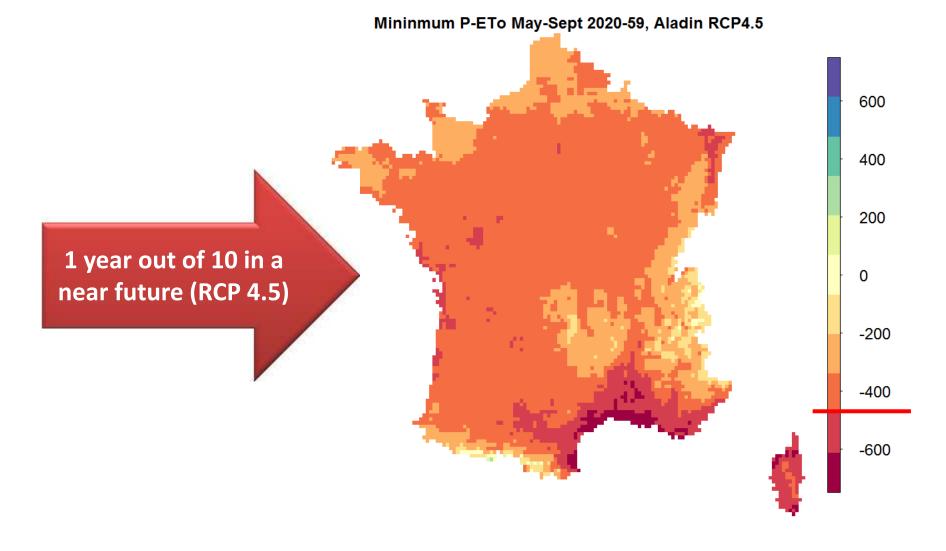
Simulation of Rye-grass production in Brittany, using the crop model STICS and the climate model Arpege (Meteo France). RCP 4.5. Durand et al 2010.

Experimental evidence of a summer water deficit **threshold** (ETO-P May-September)



 \rightarrow Only a few cultivars are adapted to Mediterranean conditions

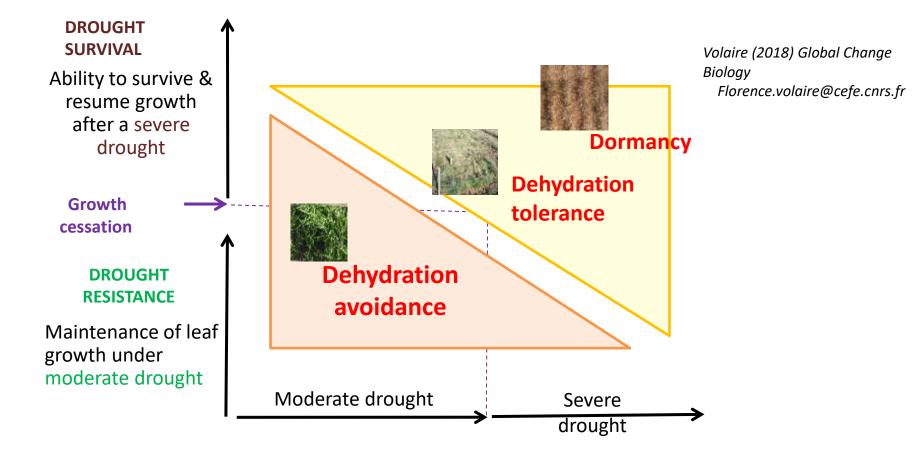




P-Eto sur May-September. Eto – P > 500 mm

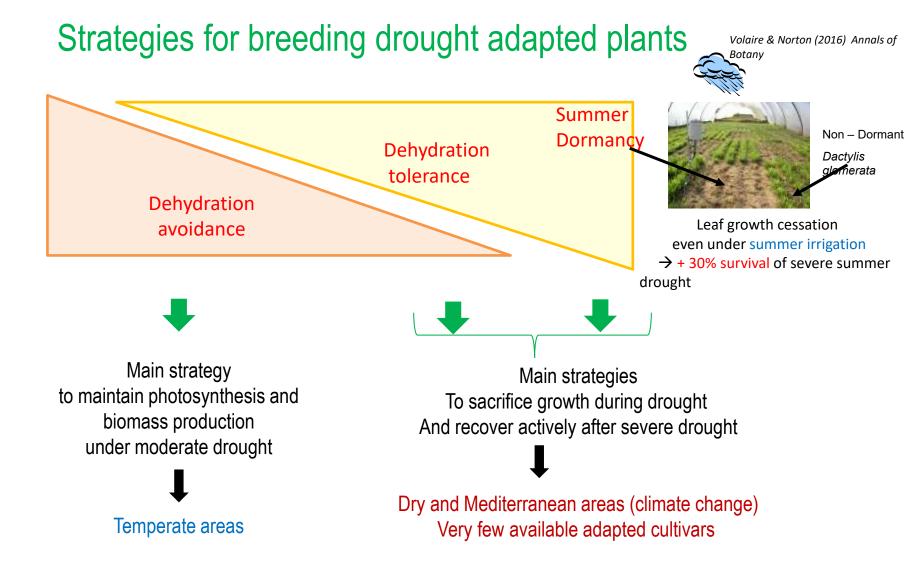


Main plant strategies to resist or SURVIVE drought



Plants cannot avoid dehydration AND tolerate dehydration

 \rightarrow Under drought: a strong trade-off between growth and survival

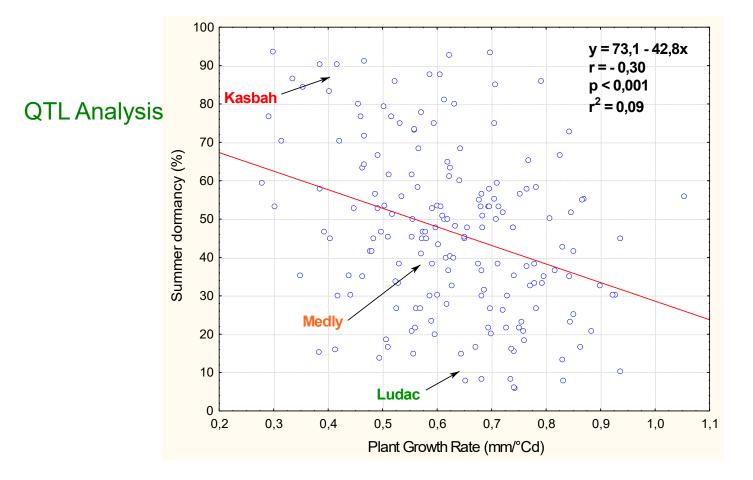


To increase dehydration tolerance & summer dormancy is increasingly important under climate change

 \rightarrow Design the right ideotypes according to the target environment

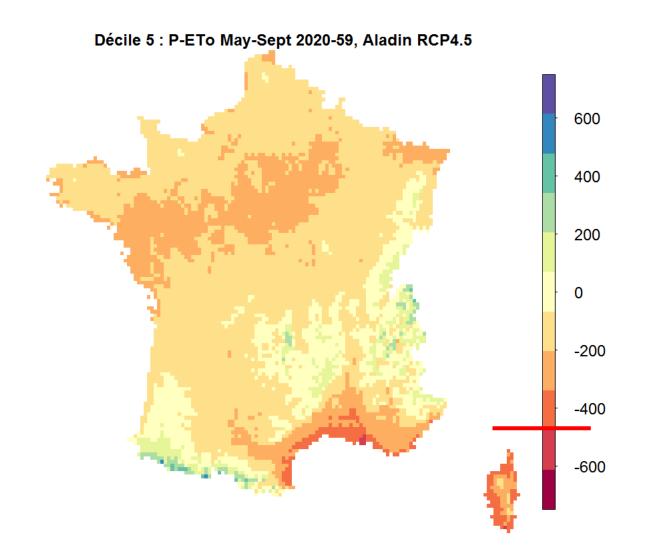
More productive and dormant cultivars, breaking the negative genetic correlation between both traits.

Understand the determinism of summer dormancy



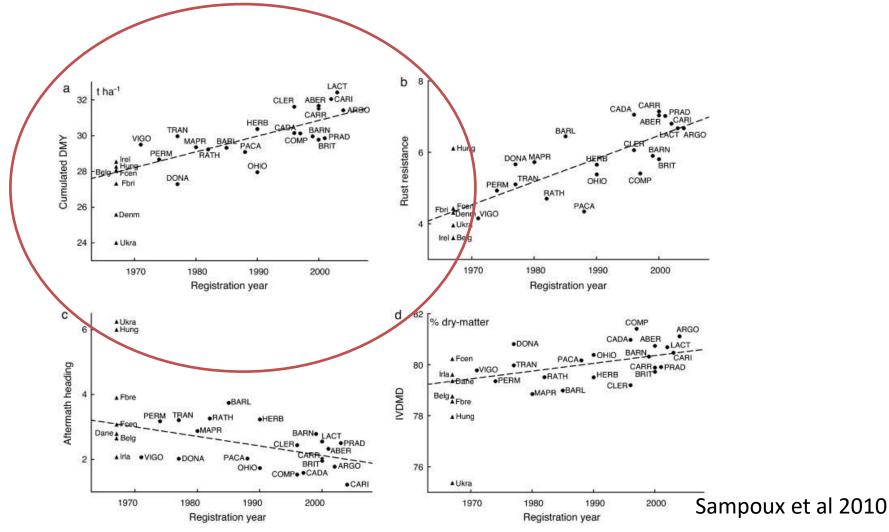
Kallida et al. (2016) Frontiers in Plant Science 7: 82

In the Temperate regions, producing high value forage throughout the year is important



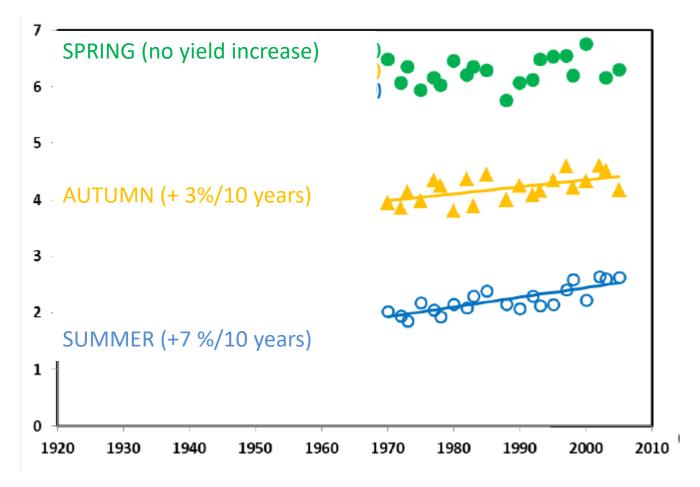


The prennial ryegrass annual yield has improved by + 10 % in 30 years: i.e. more than the negative impact of Climat change



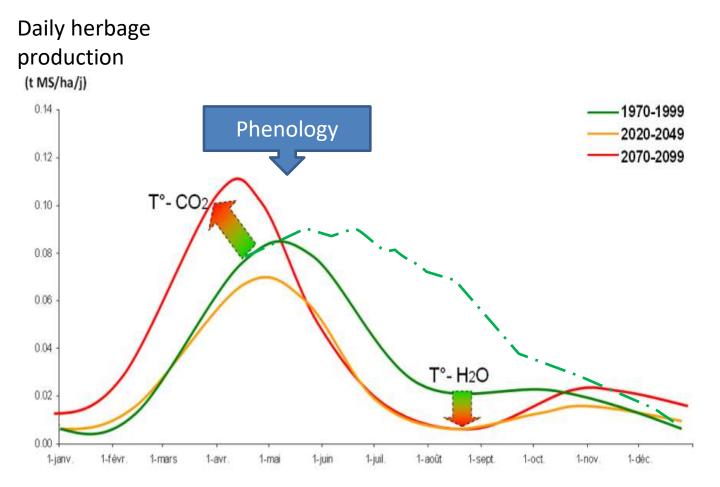


Breeders succeeded so far in reducing the negative impact of climate change in summer and autumn.



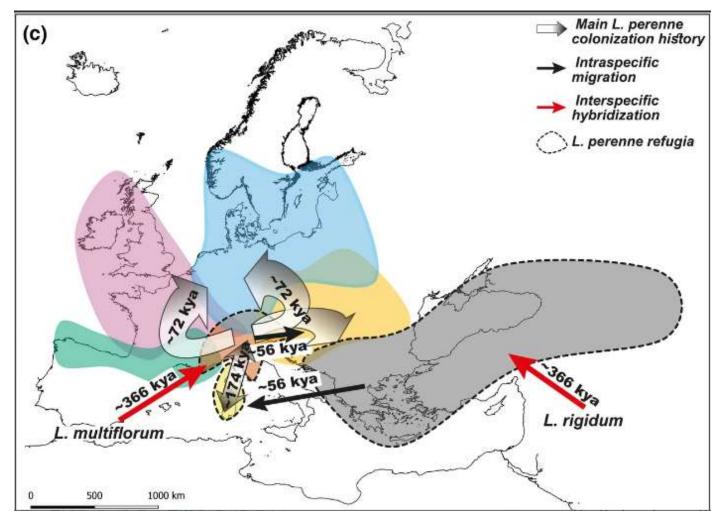


Adapt sown grasslands to Climate Change



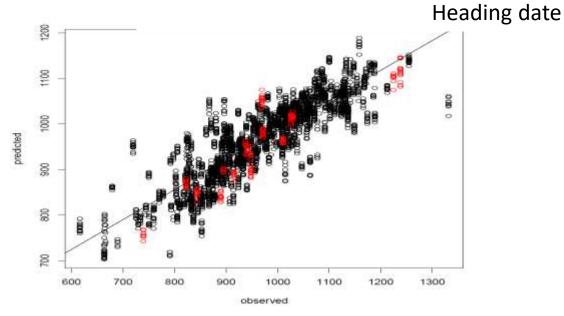
Simulation of Rye-grass production in Brittany, using the crop model STICS and the climate model Arpege (Meteo France). Durand et al 2010.

Early European expansion of *perennial ryegrass* lead to a rich underexploited variability a recent study coordinated by INRA, with European Ressource Centers, revealed.

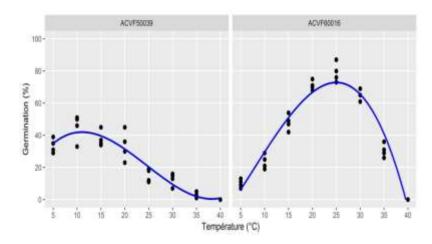


Blanco Pastor et al 2019

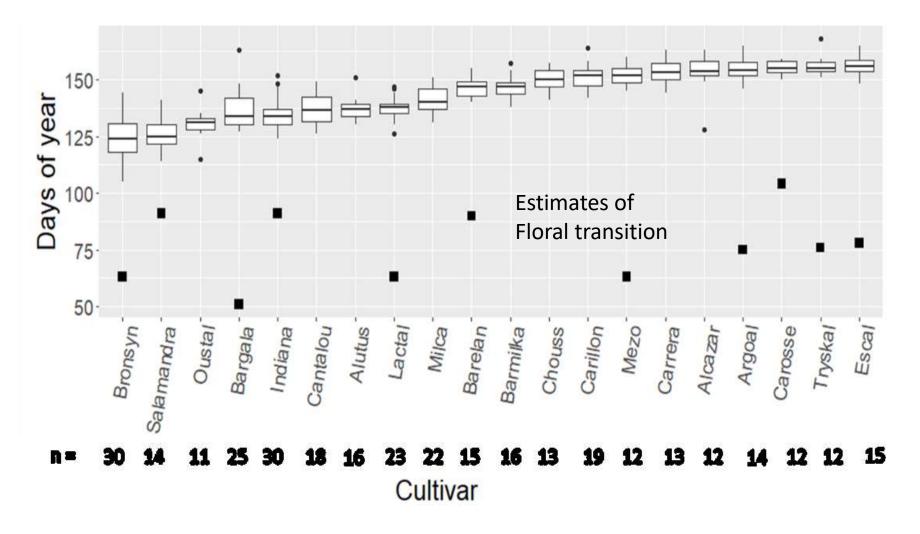
Focus on phenology: highly heritable in grasses –eg Perennial ryegrass populations in Europe/ cv.



Germination rates



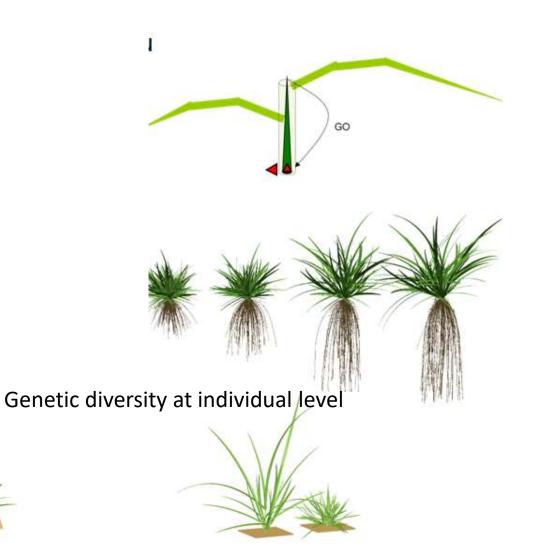
heading date and floral transition in perennial ryegrass



Data GEVES. Eucarpia meeting 2019

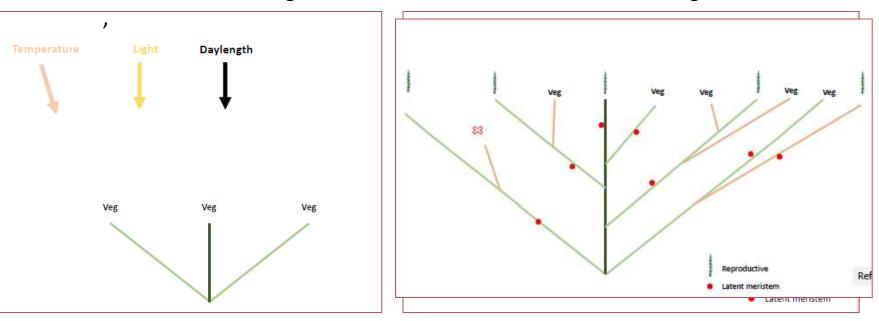
L-grass

A plant simulation model for computing ideotypes based on dynamics morphological traits



Response to cutting and management (water nitrogen...)

Simulate Phenology of forage grasses in order to understand the genetic variability of the response to climate



 \rightarrow Adding a module of floral transition and heading to L-Grass

Recent integrated progress in methodologies of phenoyping



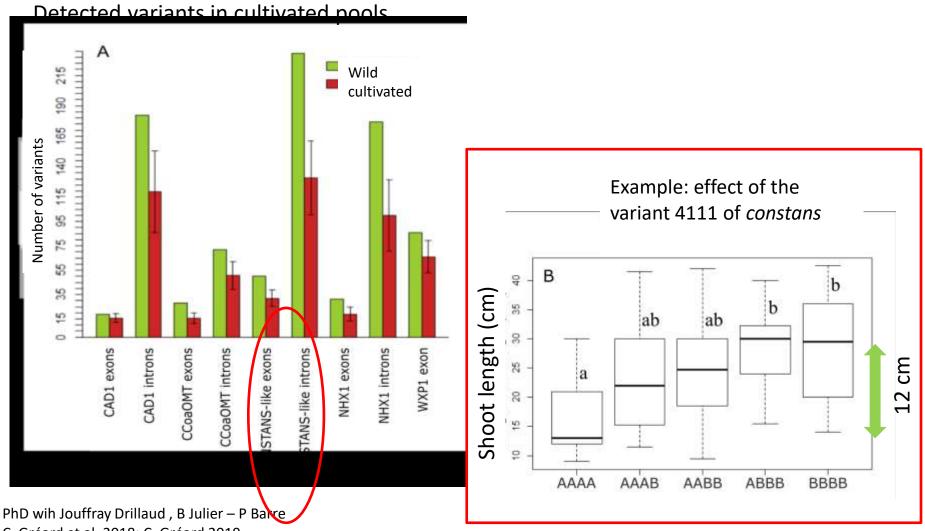
Remote sensing and canopy
«3D reconstruction



Complete chemical anaylisis coupled with Near InfraRed Spectrometry

Extreme climate Simula

Intense genetic resources investigations in lucerne. E.g; Allele mining for breeding Alfalfa



C. Gréard et al. 2018; C. Gréard 2019

- I. The importance of sown grasslands in France
- II. Adapt grasslands to climate change
- III. The challenge of breeding for multi-species grasslands
- IV. Conclusions



The need for mixed grasslands

- To reduce the dependancy of agriculture to fossil fuels, legumes must take a greater part
- But they grow slowly at first, due to
 - Initial dependancy on nitrate (before symbiosis is functionnal)
 - Initiation of shoot growth zones from bud stage (different from grasses)
- Very sensitiv to weed competition
 - \rightarrow sowing of mixtures.



\rightarrow But what composition ?

	Dispon	Densité	Sacs k	Dactyle	Fétuqu	Fétuqui	Fetuqu	Fléole	Påturin	RGA pr		1	FR	
AT-17 BIO*	В	36												
AT-106		36	20		-				Į. (N	
AT-Solvert Incarnat		35	20										N	
AT-200 Tetra	В	35	20											
AT-210 A		30	20										>	
AT-300	В	30	-	-	-	33,3		10				~	ME	2
AT-310		32	20	17.2		31,3		7,8		15,5				2
AT-323 inoculé	В	38	20	15,7		31,4		7,9						
AT-33 inoculé	В	35	20	10		22,8		4,2		10				
AT-330 M	В	33	20	16,7		36,3		7,6		10,6	1			_
AT-340	В	33	20			36,4	12,1	12,1		12,1	12,1			
AT-360		33	20					12,2	30,3	24,2	24,2			
AT-362		32	20	3	46,9				31,2	12,5				
AT-Harvestore inoculé	В	35	20			20		5,7		7,1			64,3	
AT-Legumix		30	20										90	
AT-41 F		40	20	12,5	7,5	20	7,5	7,5	25	7,5				
AT-43 RM		36	20	13,9	18,6				27,8	7,1	18			
AT-430 Extra		36	20	13,9			8,3	8,3	27,4	13,9	13,9			
AT-430 M	В	36	20	13,9			-							
AT-440 BIO*	В	32	20			_	15,6	9,4	31,3	15.6	15,6			
AT-440 Extra		32	20				15,5	9,4	31,2	15,5	15,5			
AT-440 Reno	В	20	20							100				
AT-46 Pâture		38	20		26,3	18,4			26,3	10,5	5,3			
	AT-17 BIO* AT-106 AT-Solvert Incarnat AT-200 Tetra AT-210 A AT-300 AT-310 AT-331 inoculé AT-330 M AT-340 AT-360 AT-360 AT-440 Extra AT-440 BIO* AT-440 Reno AT-440 Pâture	AT-17 BIO* B AT-106 AT-Solvert Incarnat AT-200 Tetra B AT-210 A B AT-310 B AT-330 M B AT-340 B AT-360 A AT-360 A AT-360 A AT-440 Extra A AT-440 Reno B	AT-17 BIO* B 36 AT-106 36 AT-Solvert Incarnat 35 AT-200 Tetra B 30 AT-200 Tetra B 30 AT-300 B 30 AT-310 32 AT-323 inoculé B 33 AT-330 M B 33 AT-360 33 33 AT-360 33 34 AT-360 33 34 AT-360 33 30 AT-440 B 35 AT-440 Extra 36 AT-440 Reno B 36	AT-17 BIO* B 36 20 AT-106 36 20 AT-Solvert Incarnat 35 20 AT-200 Tetra B 35 20 AT-200 Tetra B 30 20 AT-300 B 30 20 AT-310 32 20 AT-330 M B 33 20 AT-340 B 33 20 AT-360 33 20 AT-360 33 20 AT-360 33 20 AT-360 33 20 AT-462 42 20 AT-40 B 35 20 AT-430 Extra 30 20 AT-430 Extra 36 20 AT-440 BIO* B 32 20 AT-440 Reno B 20 20	AT-17 BIO* B 36 20 AT-106 36 20 AT-Solvert Incarnat 35 20 AT-200 Tetra B 35 20 AT-200 Tetra B 30 20 AT-300 B 30 20 20 AT-310 32 20 17.2 AT-323 inoculé B 33 20 18.7 AT-330 M B 33 20 16.7 AT-340 B 33 20 16.7 AT-360 33 20 47.360 33 20 AT-360 33 20 16.7 AT-362 32 20 AT-430 B 35 20 14.7 40 20 12.5 AT-430 Extra 30 20 13.9 14.44 15.90 13.9 AT-430 Extra 36 20 13.9 13.9 13.9 AT-440 BIO* B 32 20 13.9 AT-440 Reno B 20 13.9 A	AT-17 BIO* B 36 20 AT-106 36 20 36 AT-Solvert Incarnat 35 20 36 AT-200 Tetra B 35 20 36 AT-200 Tetra B 30 20 37 AT-300 B 30 20 30 AT-310 32 20 17.2 AT-323 inoculé B 38 20 15.7 AT-330 M B 33 20 16.7 AT-340 B 33 20 46.9 AT-362 32 20 16.7 AT-360 33 20 46.9 AT-430 B 35 20 16.7 AT-430 B 35 20 16.7 AT-430 B 35 20 16.7 AT-340 B 35 20 16.7 AT-430 M 30 20 15.7 AT-430 Extra 36 20 13.9 16.6 AT-430 Extra 36	AT-17 BIO* B 36 20 A AT-106 36 20 36 20 36 AT-Solvert Incarnat 35 20 36 20 37 AT-200 Tetra B 35 20 33.3 AT-300 B 30 20 20 33.3 AT-310 32 20 17.2 31.3 AT-323 inoculé B 38 20 16.7 36.3 AT-330 M B 33 20 46.9 36.4 AT-340 B 33 20 46.9 36.4 AT-360 33 20 46.9 36.4 36.4 AT-360 33 20 46.9 36.4 36.4 AT-430 B 35 20 46.9 36.4 36.4 AT-362 32 20 46.9 36.2 30 20 36.4 AT-430 Extra 36 20 13.9 46.9 36.2 30.16.6 36.2 30.16.6 36.2 36.2 30.16.6	AT-17 BIO* B 36 20 I AT-106 36 20 I I AT-Solvert Incarnat 35 20 I I AT-200 Tetra B 35 20 I I AT-200 Tetra B 35 20 I I AT-200 Tetra B 30 20 I I AT-300 B 30 20 I I AT-310 32 20 17.2 31.3 AT-310 32 20 16.7 31.4 AT-330 M B 33 20 16.7 36.3 AT-340 B 33 20 16.7 36.3 AT-362 32 20 46.9 I I AT-462 32 20 46.9 I I AT-430 B 35 20 20 I I AT-430 B 35 20 20 I I I AT-430 B 35 20<	AT-17 BIO* B 36 20 I I AT-106 36 20 I I I AT-Solvert Incarnat 35 20 I I I AT-200 Tetra B 35 20 I I I AT-300 B 30 20 I I I AT-300 B 30 20 II I I AT-310 32 20 II II 7.8 AT-323 inoculé B 38 20 II III 7.8 AT-330 M B 33 20 III III 7.8 AT-340 B 33 20 III IIII IIII IIII IIIII IIIII IIIIIIIII IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII	AT-17 BIO* B 36 20 I I I AT-106 36 20 I	AT-17 BIO* B 36 20 I I AT-106 36 20 I I I AT-Solvert Incarnat 35 20 I I I AT-200 Tetra B 35 20 I I I AT-300 B 30 20 I I I AT-300 B 30 20 I I I AT-310 32 20 I72 31.3 7.8 15.5 AT-33 inoculé B 38 20 16.7 36.3 7.6 10.6 AT-340 B 33 20 I6.7 36.3 7.6 10.6 AT-360 33 20 I6.7 36.3 7.6 10.6 AT-360 33 20 I6.7 36.3 7.6 10.6 AT-360 33 20 I6.7 7.1 11.2 12.1 12.1 12.1 12.1 12.1 12.1 12.1 12.1 12.1 12.1 12.1 12.1	AT-17 BIO* B 36 20 Image: state sta	AT-17 BIO* B 36 20 Image: constraint of the strain of the straint	AT-17 BIO* B 36 20 Image: Constraint of the state of the

33 20

Nbre d'an d'exploit

/elange

pour

cultures 1 an

pour cultures

1 à 2 ans

Milano

pour cultures

3 à 4 ans

Mélange

elano pour

cultures

INTERÊT DES MÉLANGES



9.4

9,4

3,1

3.1

6,6

5,5 +++ ++ +++ ++ Méla

++++++ +++ Mék

++ ++ ++ ++ +++ Mél:

++ Mál:

++ +++ Mél + Méla

+++ Méla

3,8 6,2

4.2 6,9

4.2 6.9

4,2 6,9

3,1 6,3

3,1 6,3

2,5 7,5

2,7 3,9

annuel, très appétent, gélif, si culture dérobée né annuel, très appétent, gélif, excellente digestibilit hivemant pour ensilage de printemps, une coupe extra productif, excellentes valeurs alimentaires 12-18 mois hivemant, excellentes valeurs aliment ensilage avec RGH pour zone séchante. TV longu plus précoce que le 330 M grâce au RGH pour en uzernier extra productif, la fétuque des prés per avec luzerne, peut convenir aux zones peu fa fauche, le must des mélanges en moyenne du

6.1 ++++++++++++++ Mélange moyenne durée très polyvalent pour zone fave ++ + ++ ++ Mélange pâture à base de trèfie viclet pour pâture, sans ++ ++ ++ +++ Mélange páture à base de trèfle violet pour pâture, situa 2,9 +++ ++ +++ -Mélange luzernier pour ensilage, gros volume, excellent 10 +++ ++ +++ +++ - Mélange de légumineuses pour fauche ou interculture lo 2.5 ++ +++ ++ +++ Mélange longue durée d'altitude (ou le ray grass ne tient 5.5 ++++ +++ ++ Mélange longue durée pour conditions difficiles, très bor 2,8 +++ +++ +++ Mélange longue durée très polyvalent. le must des méla

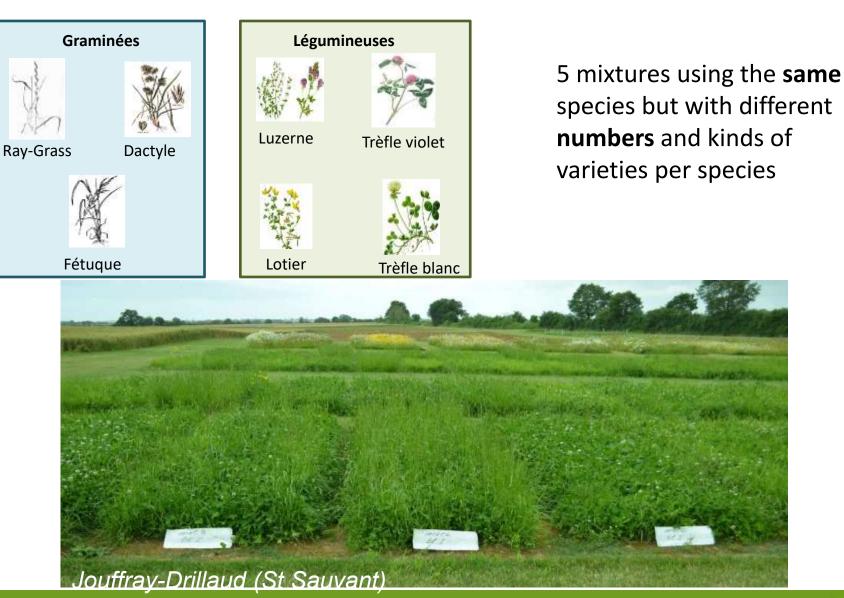






RGT STOX PROTÉINE 4

Demonstrating the importance of some intraspecific diversity

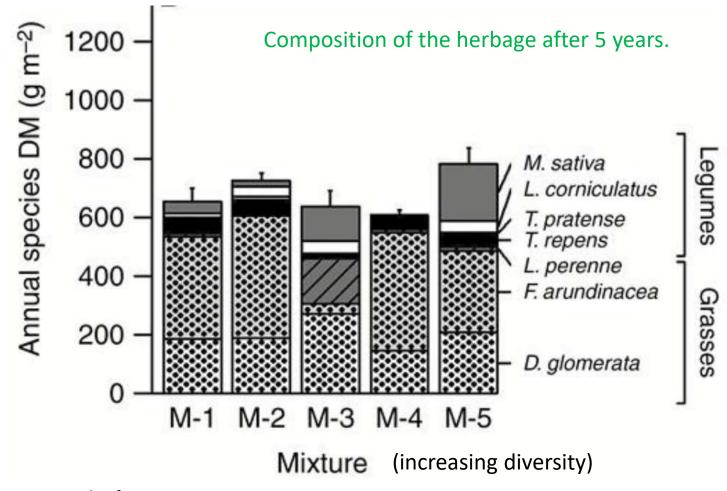




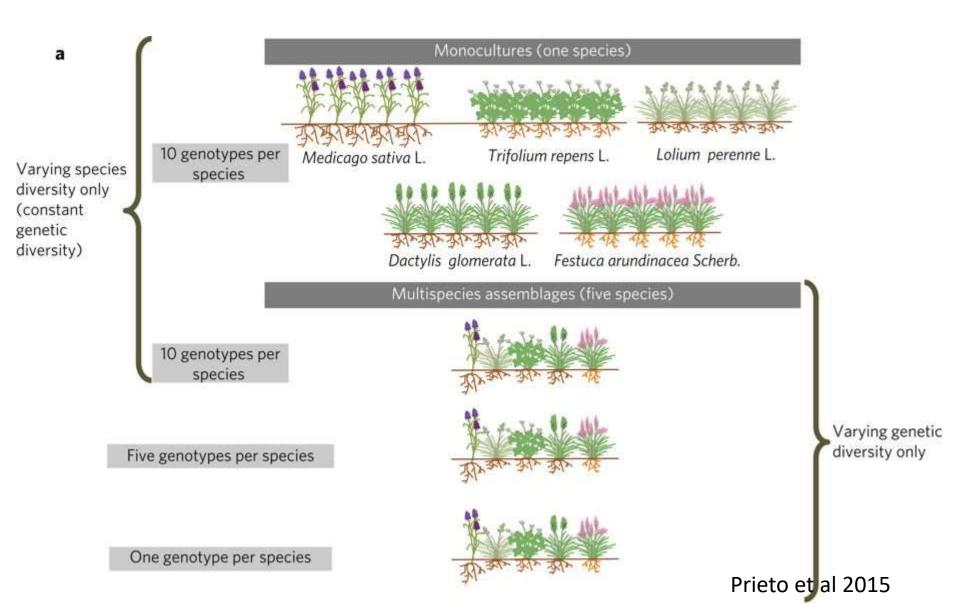
Many cultivars are better than the best ones in pure stands.

→ Stability

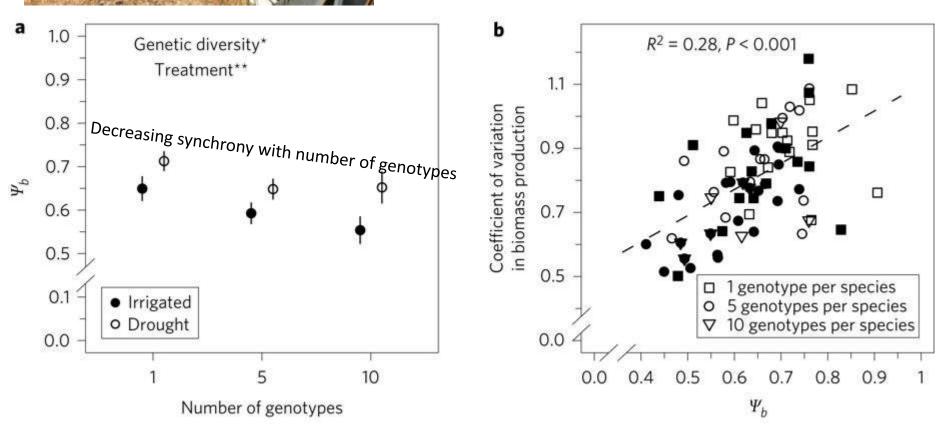
\rightarrow Legume proportion in herbage

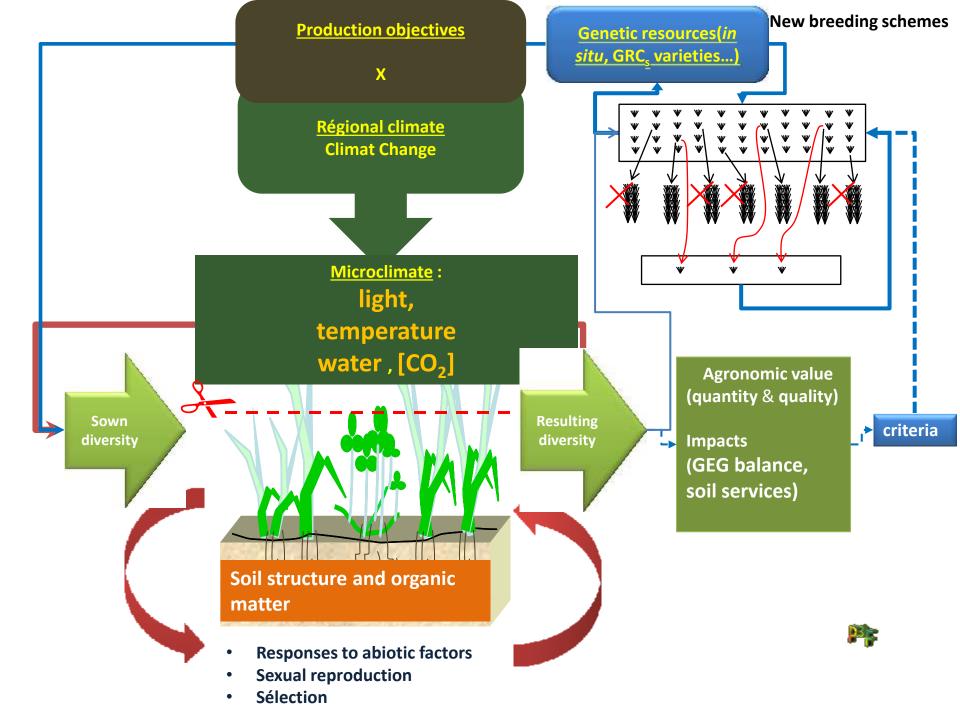


According to another experiment, the reason appears to be the intraspecific variability of phenology.



Intra specific differences in **phenology** improved species mixtures stability





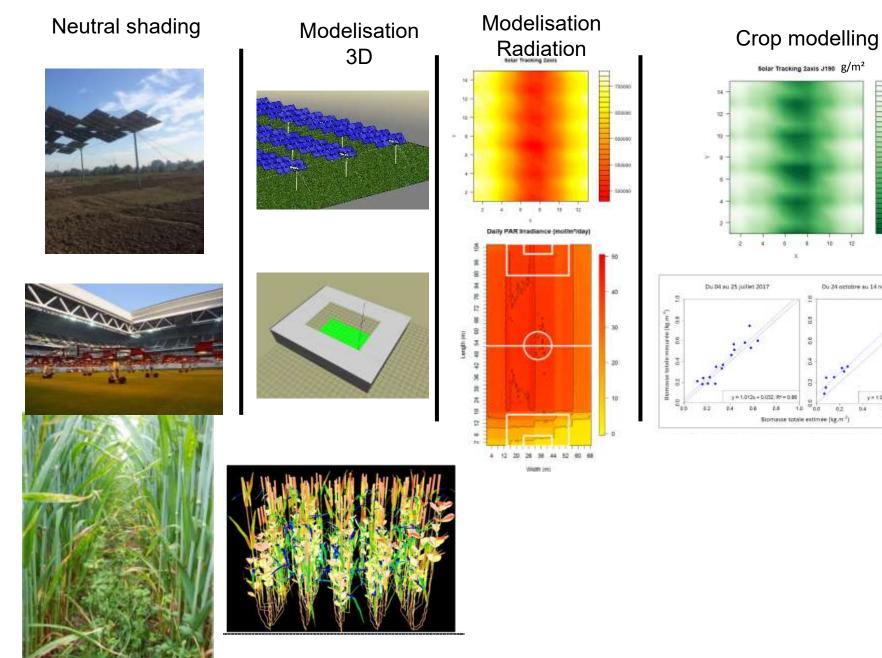
Extension of our knowledge to other area:

Turf and forage biomass management under stadium covers, solar panels, cereals...

v = 1.028x + 0.094 R² = 0.8

Du 24 octobre au 14 novembre 2017

1.0



- I. The importance of sown grasslands in France
- II. Adapt grasslands to climate change
- III. The challenge of breeding for multi-species grasslands
- IV. Conclusions



Conclusion

The role of sown grassland in ecological intensification is crucial

Despite of- and due to the intrinsic diversity, forage cultivars exhibit

- Most efficient feed for cattle
- Strong <u>resilience</u> to climate change
- Consistent margins of genetic progress

Collection, study and conservation of genetic resources was and will remain crucial

INRA is engaged with multiple partnerships at Local, National and European levels in both private and public sectors.





