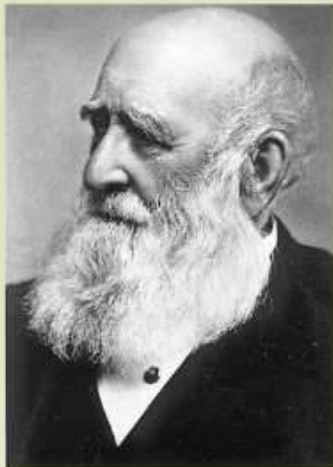


The History of Rothamsted

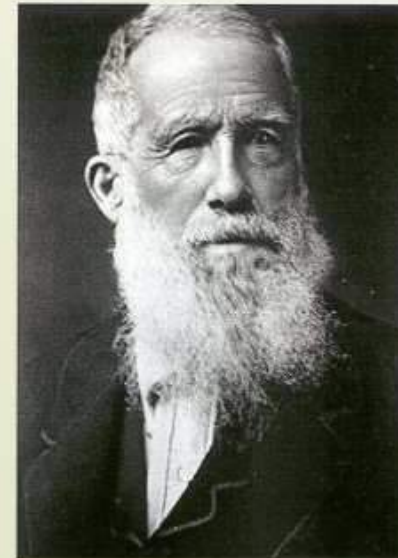


**Earliest Rothamsted
experiment started 1843**



Sir Joseph Henry Gilbert

Sir John Bennet Lawes






ROTHAMSTED
RESEARCH

RoCRE
Rothamsted
Centre for Research & Enterprise


Lawes
Agricultural
Trust


B
ros

The Rothamsted Long-term Experiments (LTEs)

The Classical Experiments:

- Broadbalk Wheat Experiment (1843)
- Park Grass Hay (1856)
- Hoos Barley (1852)
- The Exhaustion Land (1856)
- Garden Clover (1854)
- Broadbalk Wilderness (1882)
- Geescroft Wilderness (1886)

- The Alternate Wheat and Fallow (1851) – modified 2015
- Barnfield (1843-1994) – mothballed since 2001
- Agdell (1848-1990) – discontinued

Other LTE's:

- The Woburn Ley-Arable (1938)
- Highfield Ley-Arable (1948)
- Fosters Ley-Arable (1948)
- Highfield Permanent Bare Fallow (1959)
- Woburn Market Garden (1942)
- Woburn Organic Manuring (1964)

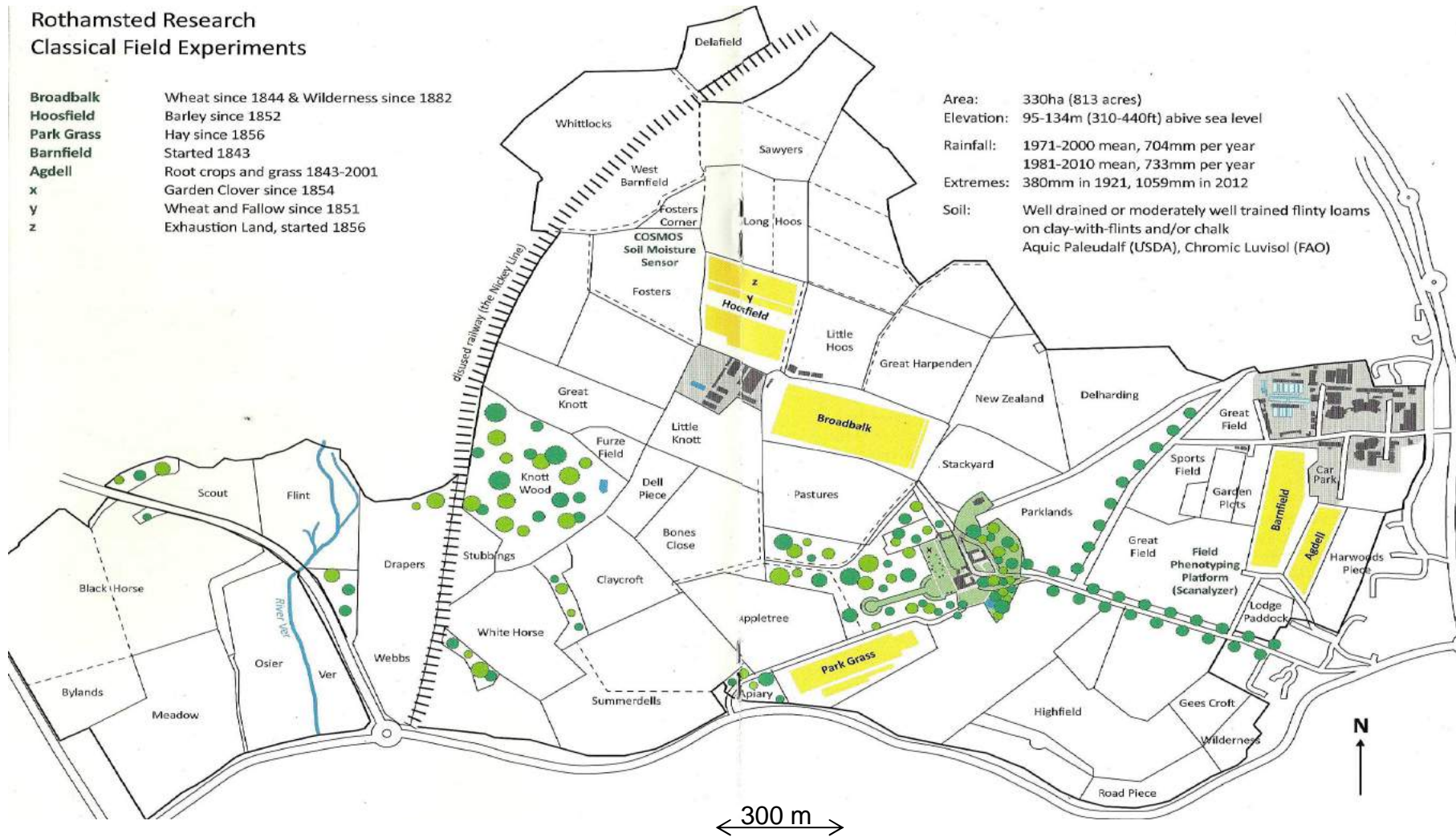
- Rothamsted and Woburn Straw Incorporation experiments (1987) - discontinued
- Rothamsted and Woburn Continuous Maize Experiments (1997) - discontinued

Parcelles d'essai historiques de Rothamsted Research

Rothamsted Research Classical Field Experiments

Broadbalk	Wheat since 1844 & Wilderness since 1882
Hoosfield	Barley since 1852
Park Grass	Hay since 1856
Barnfield	Started 1843
Agdell	Root crops and grass 1843-2001
x	Garden Clover since 1854
y	Wheat and Fallow since 1851
z	Exhaustion Land, started 1856

Area: 330ha (813 acres)
 Elevation: 95-134m (310-440ft) above sea level
 Rainfall: 1971-2000 mean, 704mm per year
 1981-2010 mean, 733mm per year
 Extremes: 380mm in 1921, 1059mm in 2012
 Soil: Well drained or moderately well trained flinty loams on clay-with-flints and/or chalk
 Aquic Paleudalf (USDA), Chromic Luvisol (FAO)



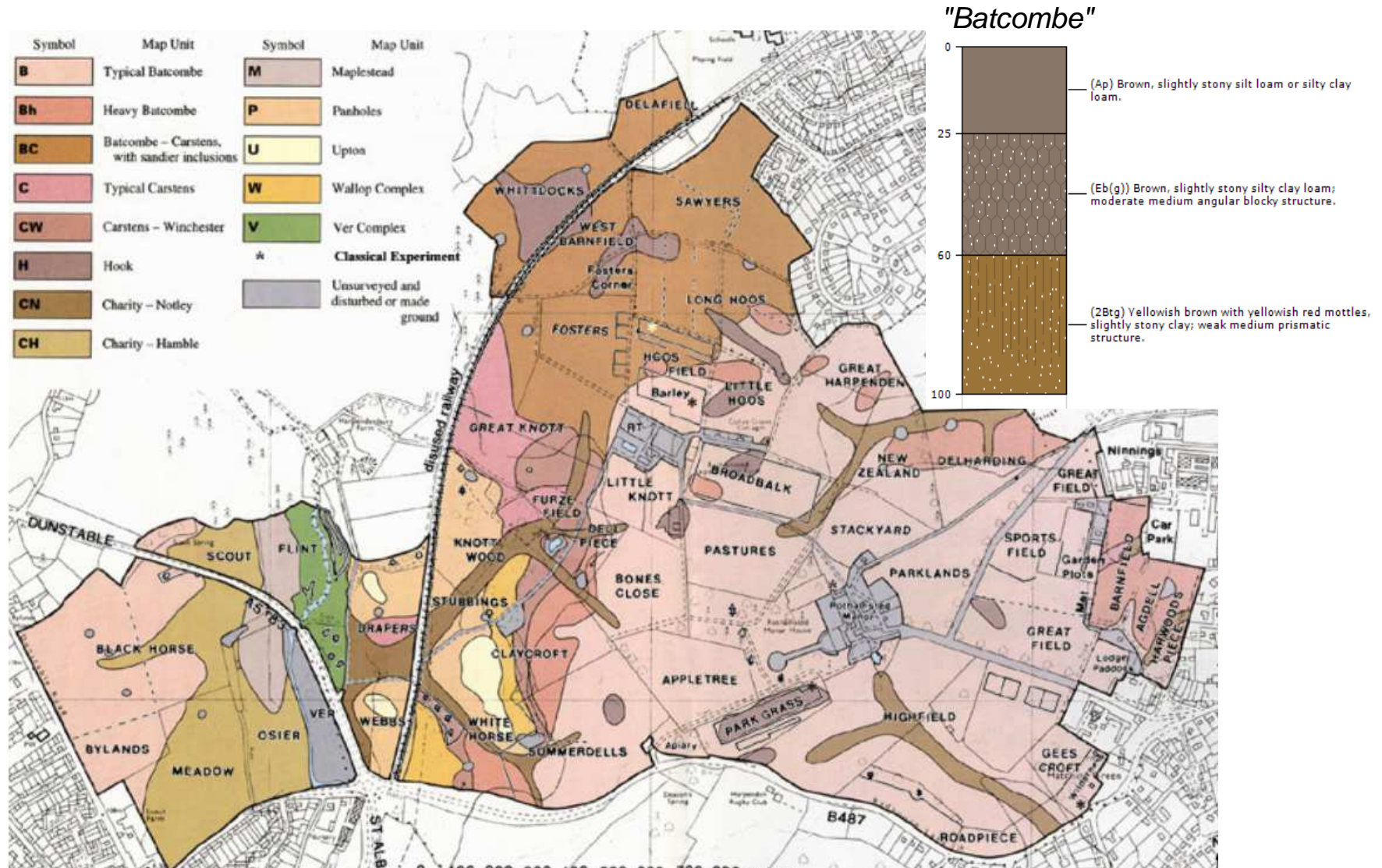


The Rothamsted Sample Archive

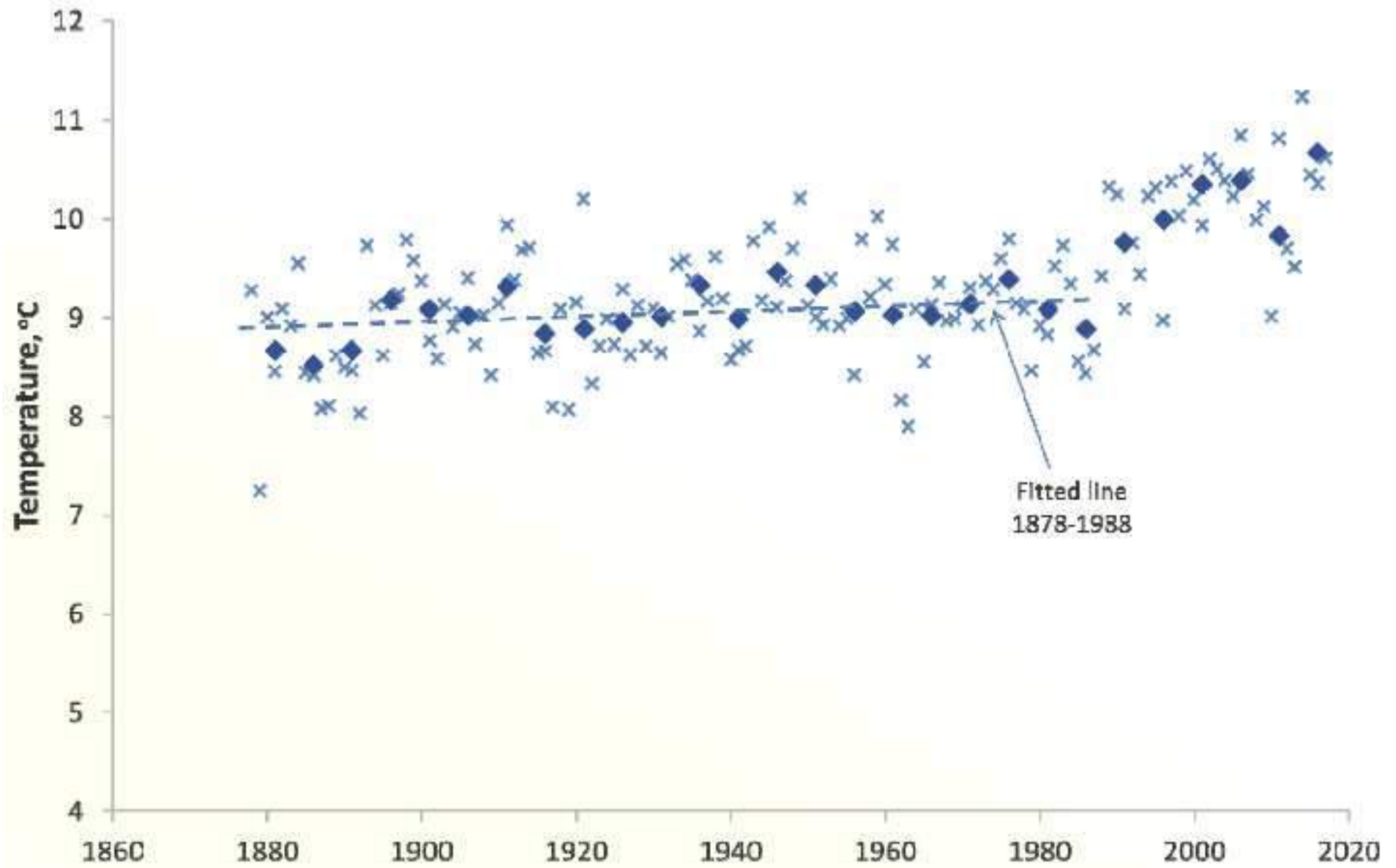
The archive contains about 300,000 grain, straw, herbage, soil, fertilizer and manure samples, some dating back to 1843.

- Yield – Grain & Straw (selected plots), herbage
- Grain Quality – TGW, HLW, HFN.
- Plant analyses (selected plots) – Total N, Majors (P, K, Ca, Na, Mg, S), botanical surveys.
- Regular soil sampling & analyses - Total N & C, Exchangeable Cations (K, Mg, Ca, Na), Olsen P, pH, CaCO_3 .

Types de sols : limoneux



Même en Angleterre



Essai Broadbalk - Le plus connu du monde ?

Broadbalk



1843 – 1926: Single plots comparing N, P, K fertilizers and organic manures.

1926: Plots split into 5 sections – to introduce following for weed control



1968: Plots split into 10 sections

- Crop rotations (W,W,O,W,Be since 2018)
- New shorter wheat varieties
- Higher N rates
- Herbicides and fungicides
- Straw incorporation (section 0, since 1986)

2001: N Split on some plots
P Withheld on some plots
S Withheld on plot 14

Essai Broadbalk – Le témoin "historique"





Long term Fertilization Trials in Rothamsted Research



Essai Broadbalk - Modalités testées

Amendements (0 vs N, P, K, Mg : 254, 44, 351, 26 kg/ha)

Doses N (48, 96, 144, 192, 240, 288 kg . ha⁻¹)

Fractionnement N (1 ou 3 apports)

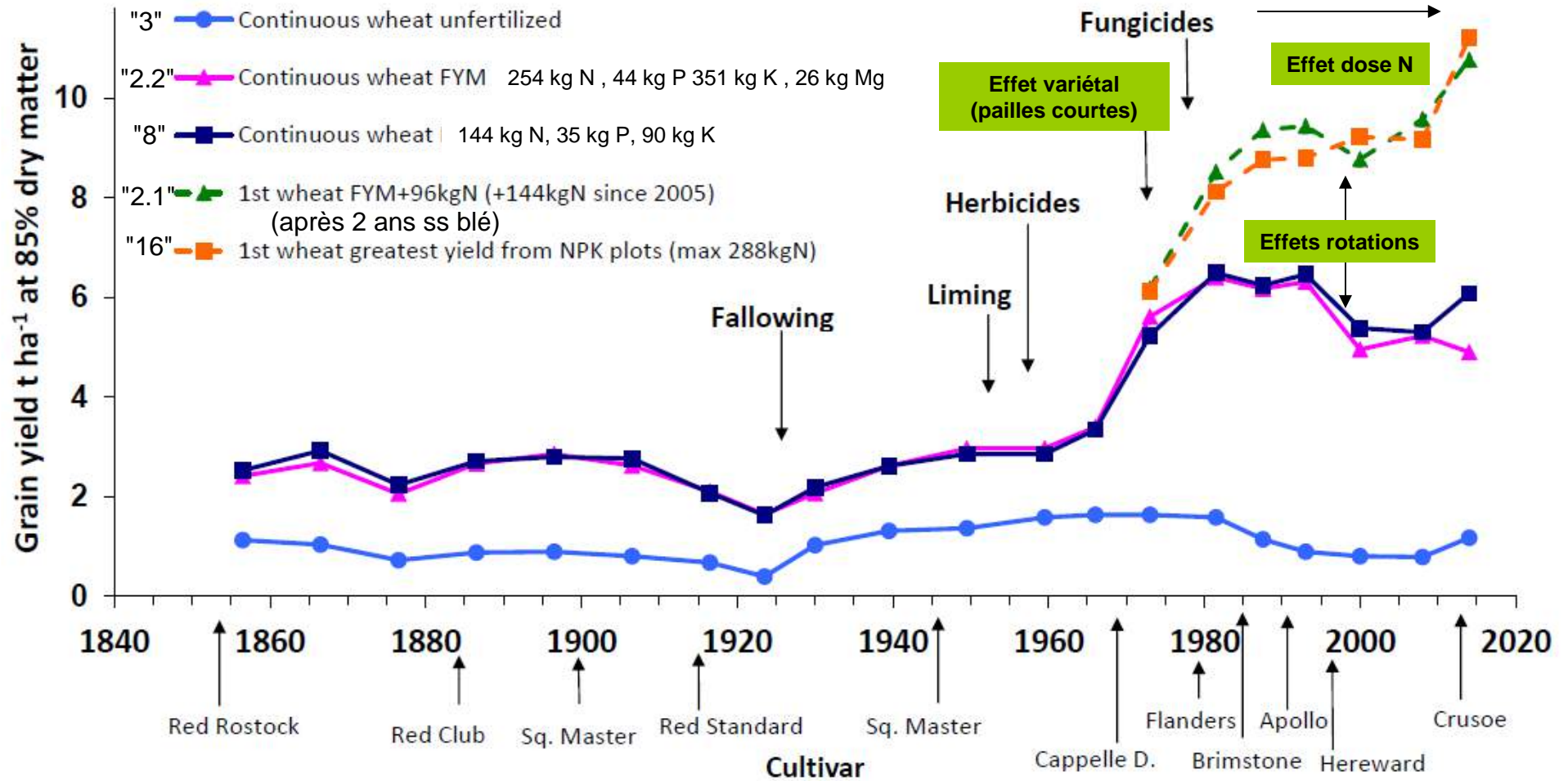
Rotations (blé/blé vs 1^{er} blés)

Mg (0 -12 - 24 kg . ha⁻¹)

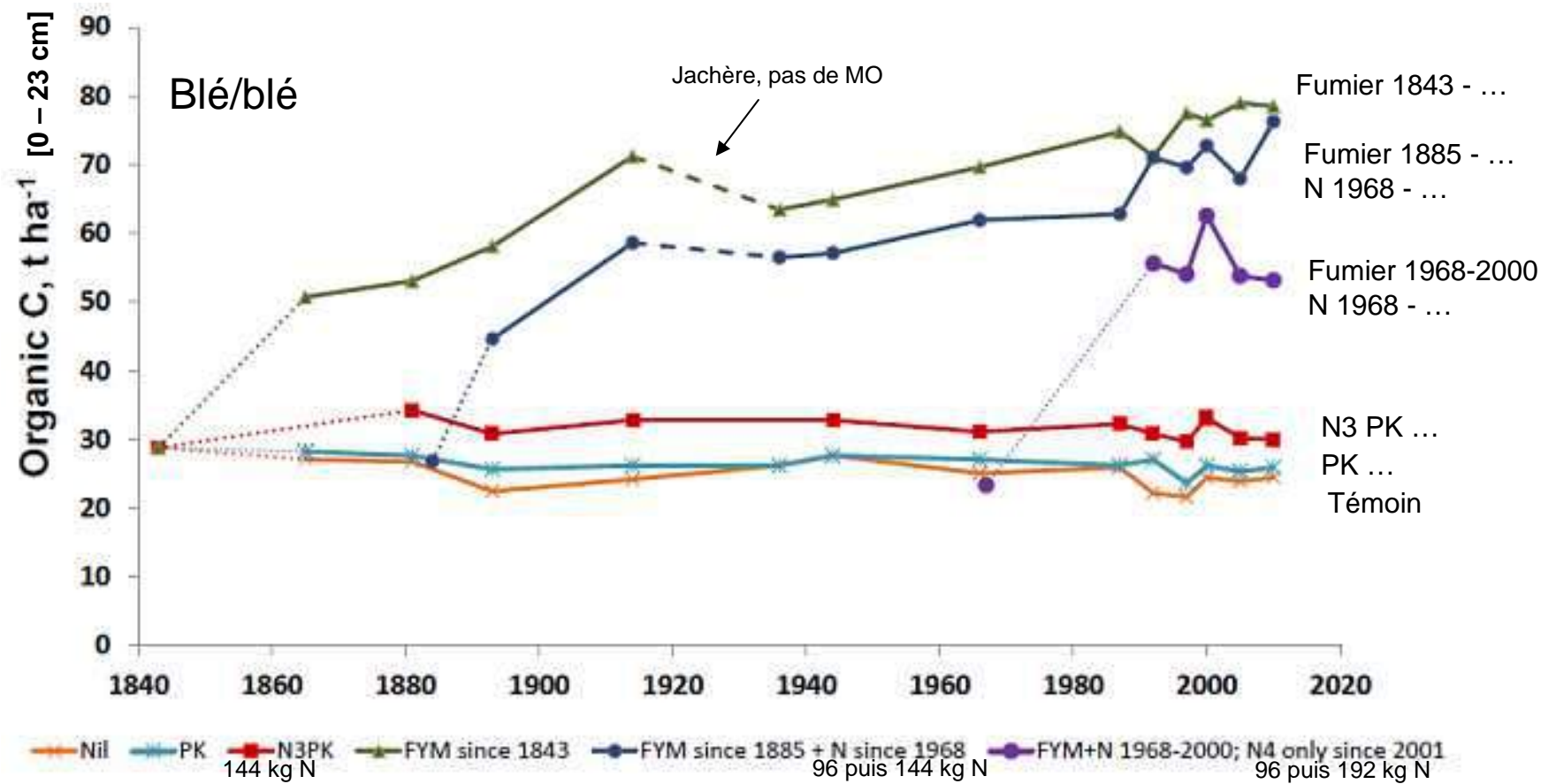
K (0 – 90 - 180 kg . ha⁻¹)

P (0 – 35 kg . ha⁻¹)

Essai Broadbalk - Résultats généraux - Rendements

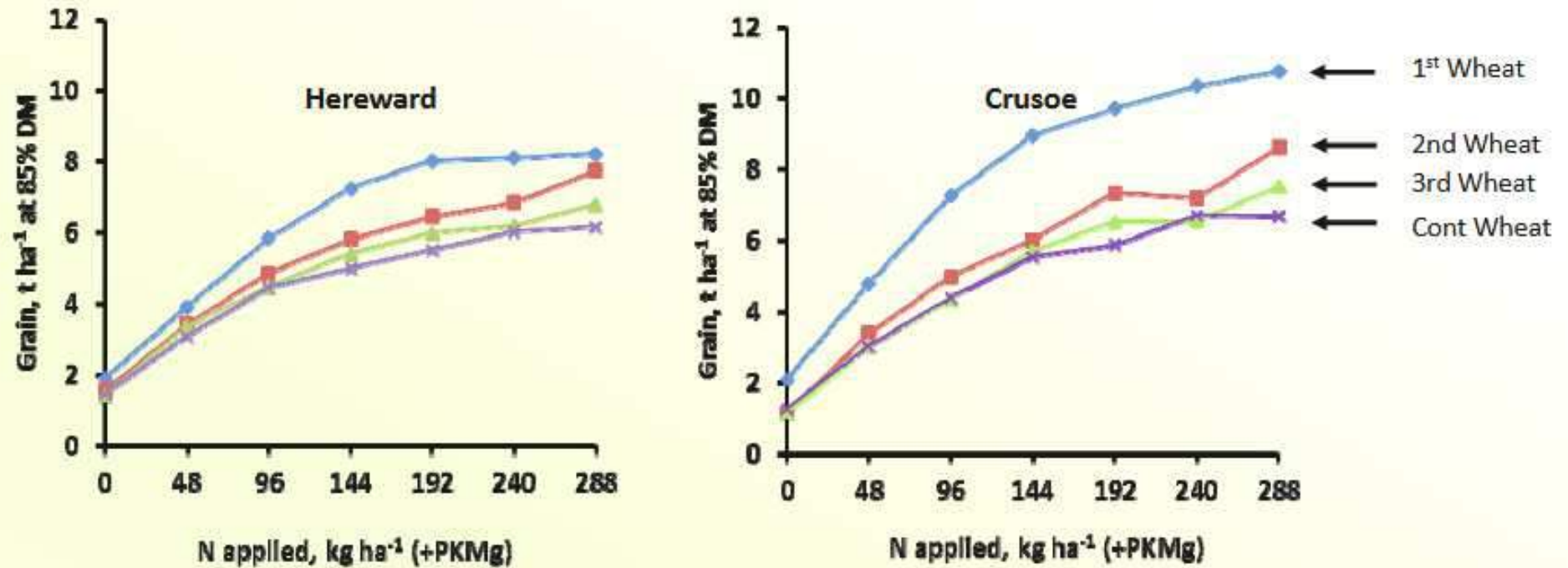


Essai Broadbalk - Résultats généraux – Carbone organique



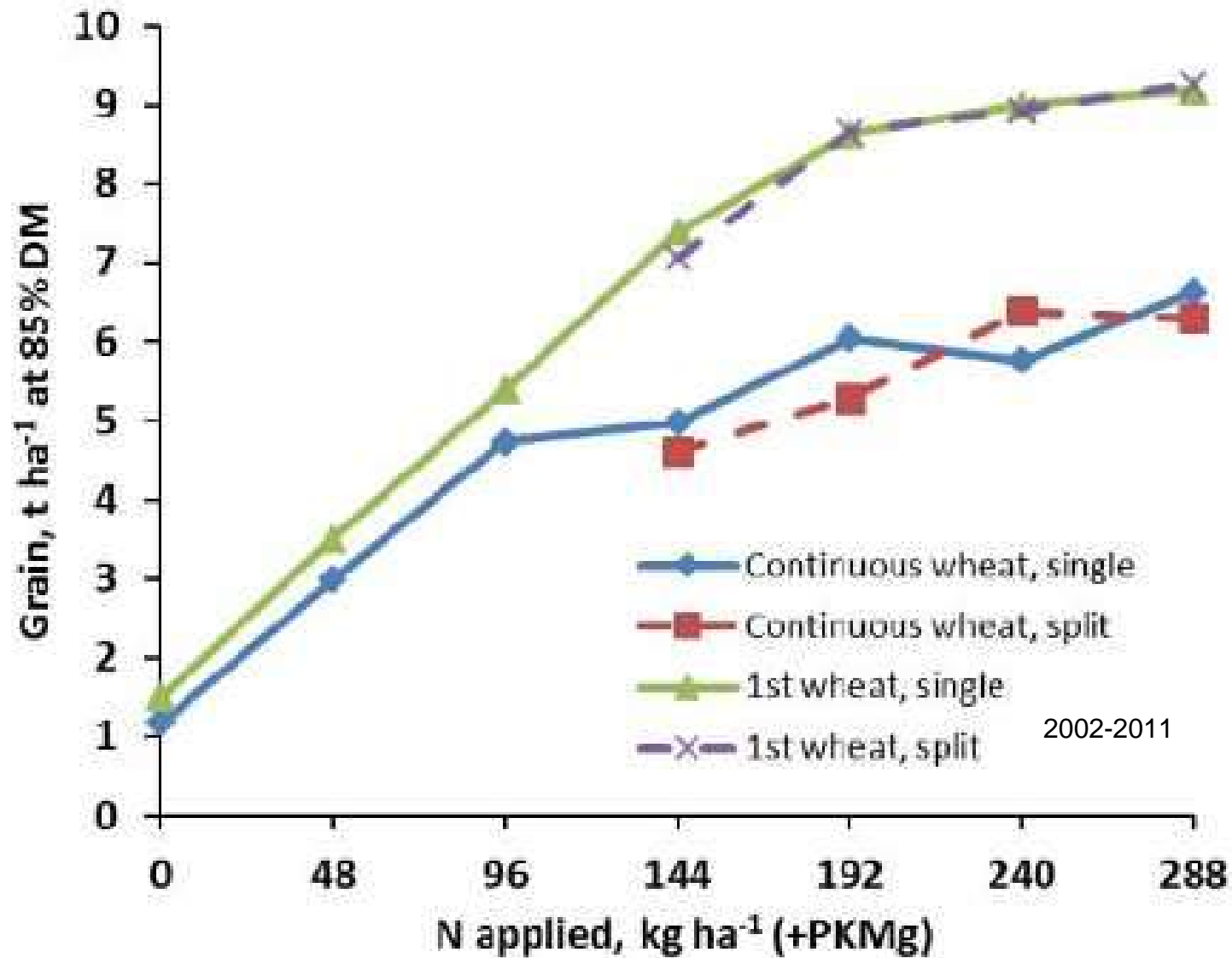
Essai Broadbalk - Résultats généraux - Effets monoculture

Mean Yield Comparison of Hereward (2009-12) v Crusoe (2013-17) on Broadbalk.

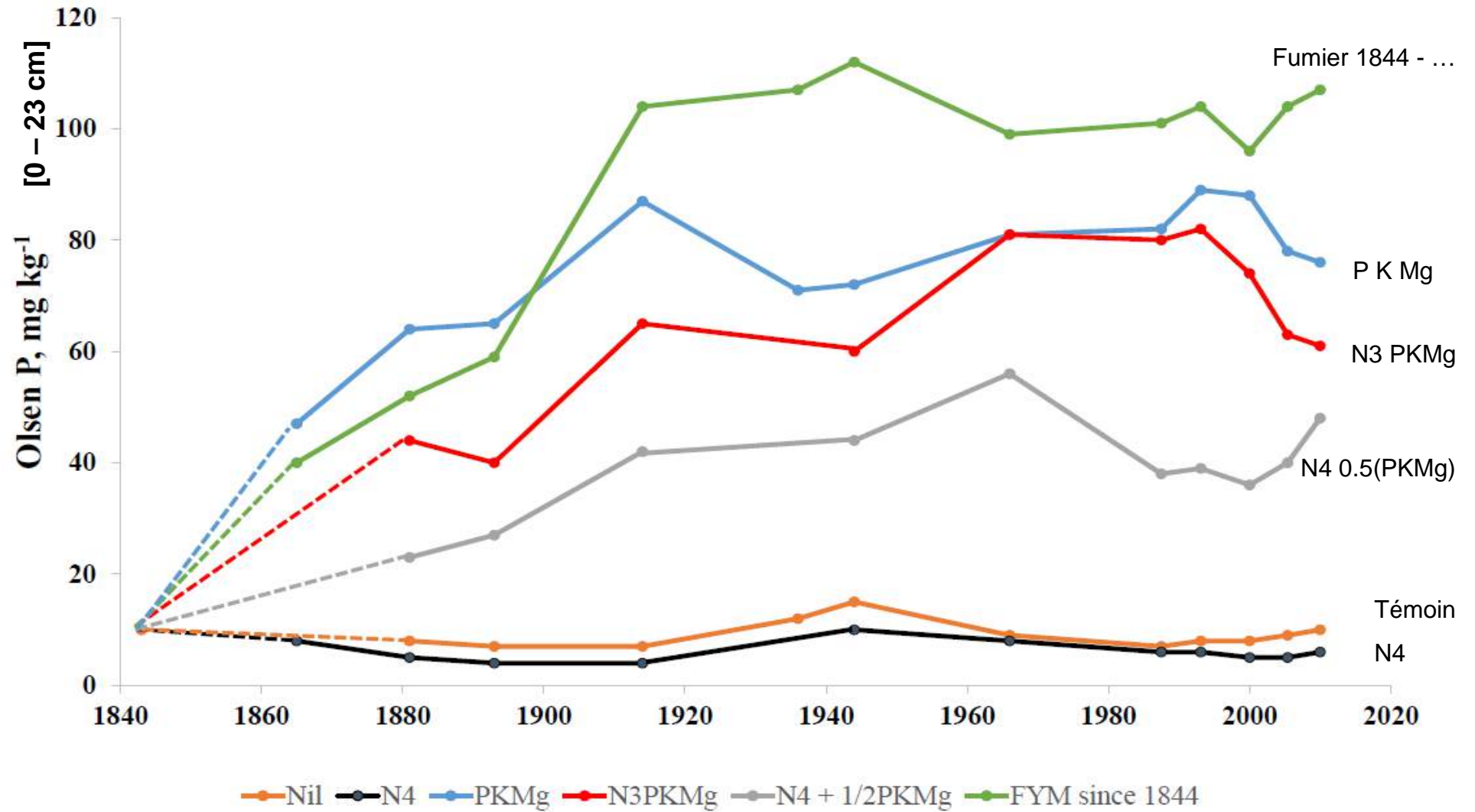


(P, K, Mg & N, P, K, Mg plots only)

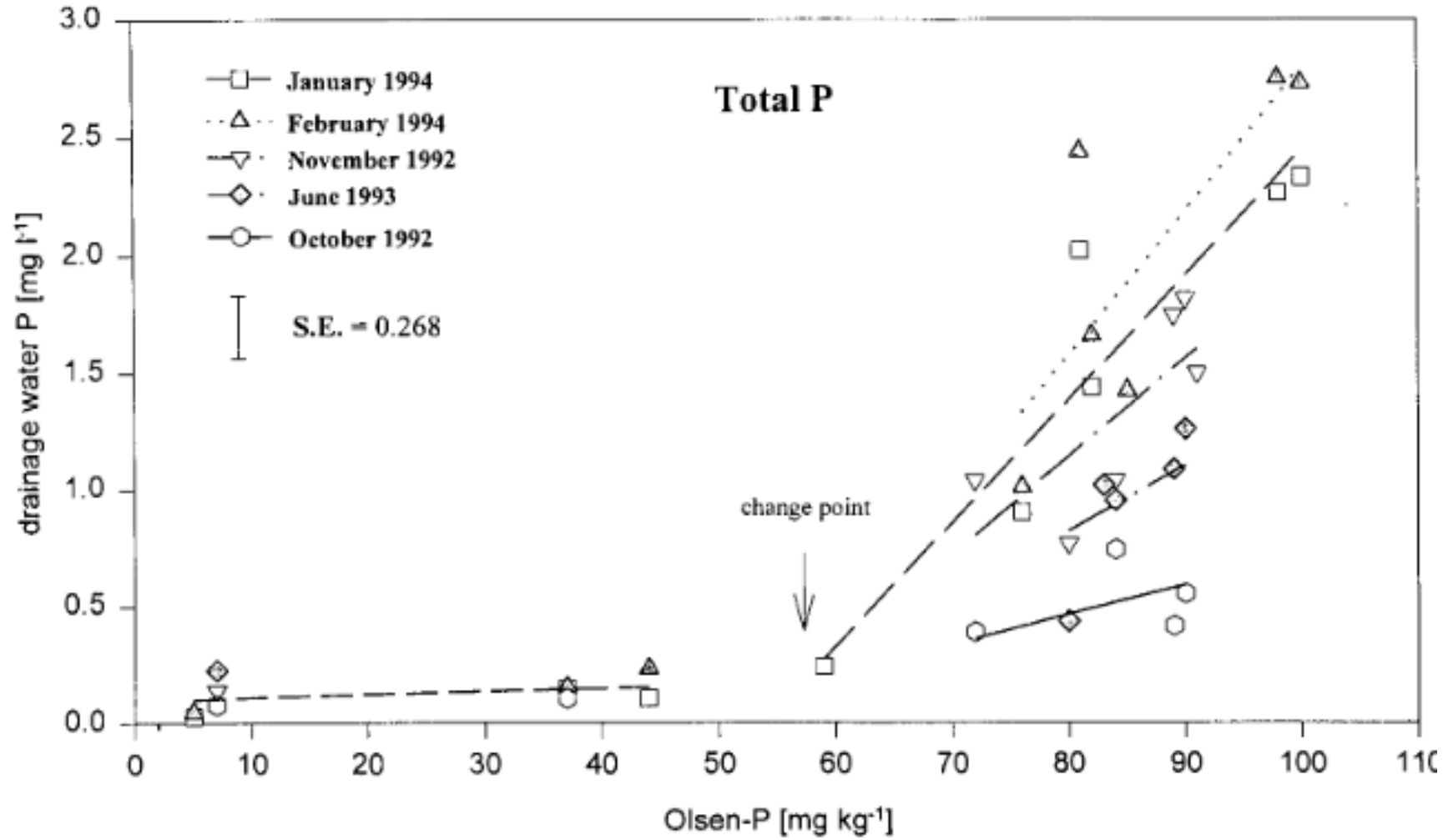
Essai Broadbalk - Résultats généraux - Effets du fractionnement de ferti N



Essai Broadbalk - Résultats P



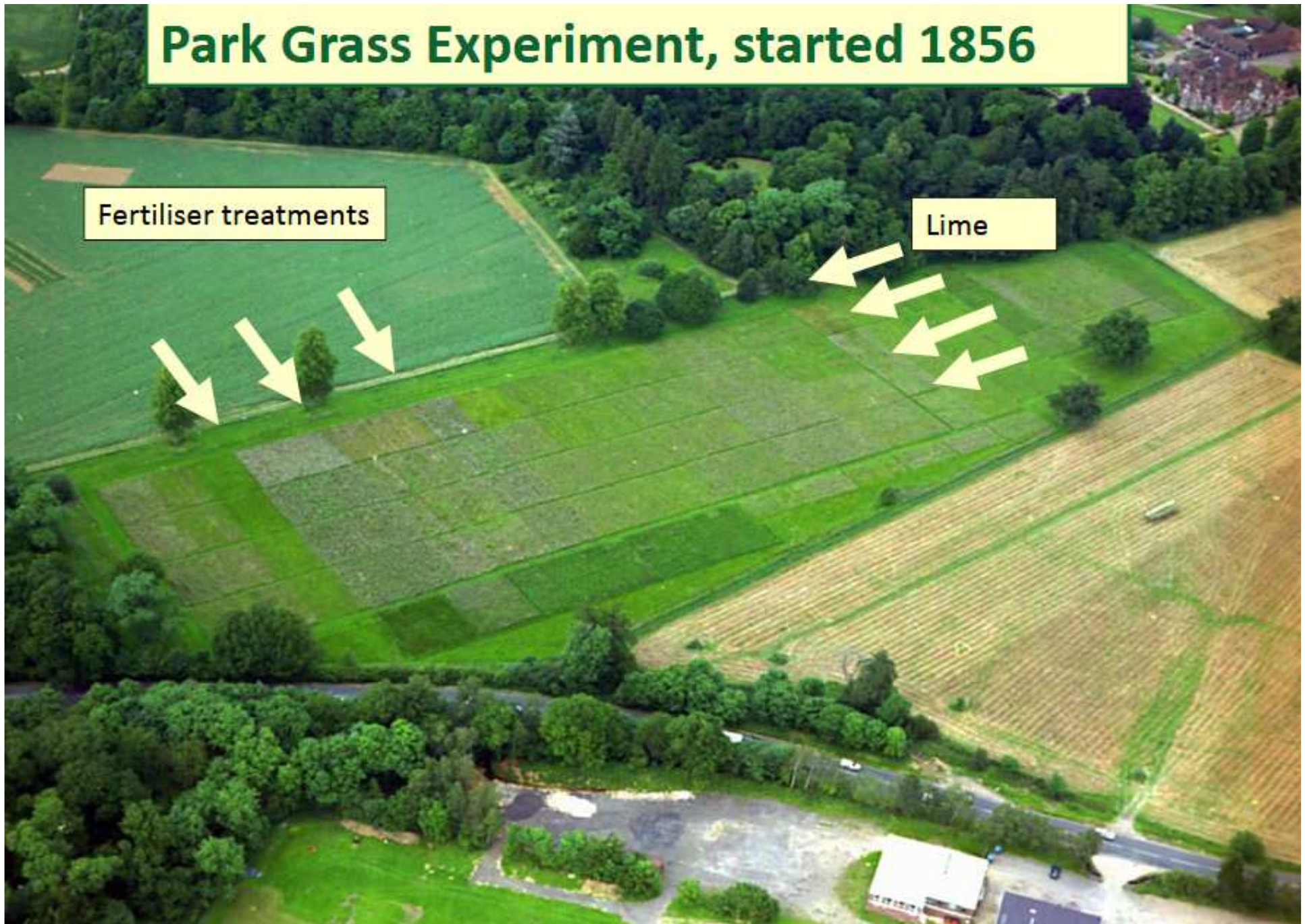
Essai Broadbalk - Résultats P



Park Grass Experiment, started 1856

Fertiliser treatments

Lime



Essai Park Grass - Modalités testées

Amendements (0 vs N, P, K, Mg, Ca : 240, 45, 350, 25, 135 kg/ha)

Doses N (48, 96, 144, kg . ha⁻¹)

Formes N (NH₄⁺ vs NO₃⁻)

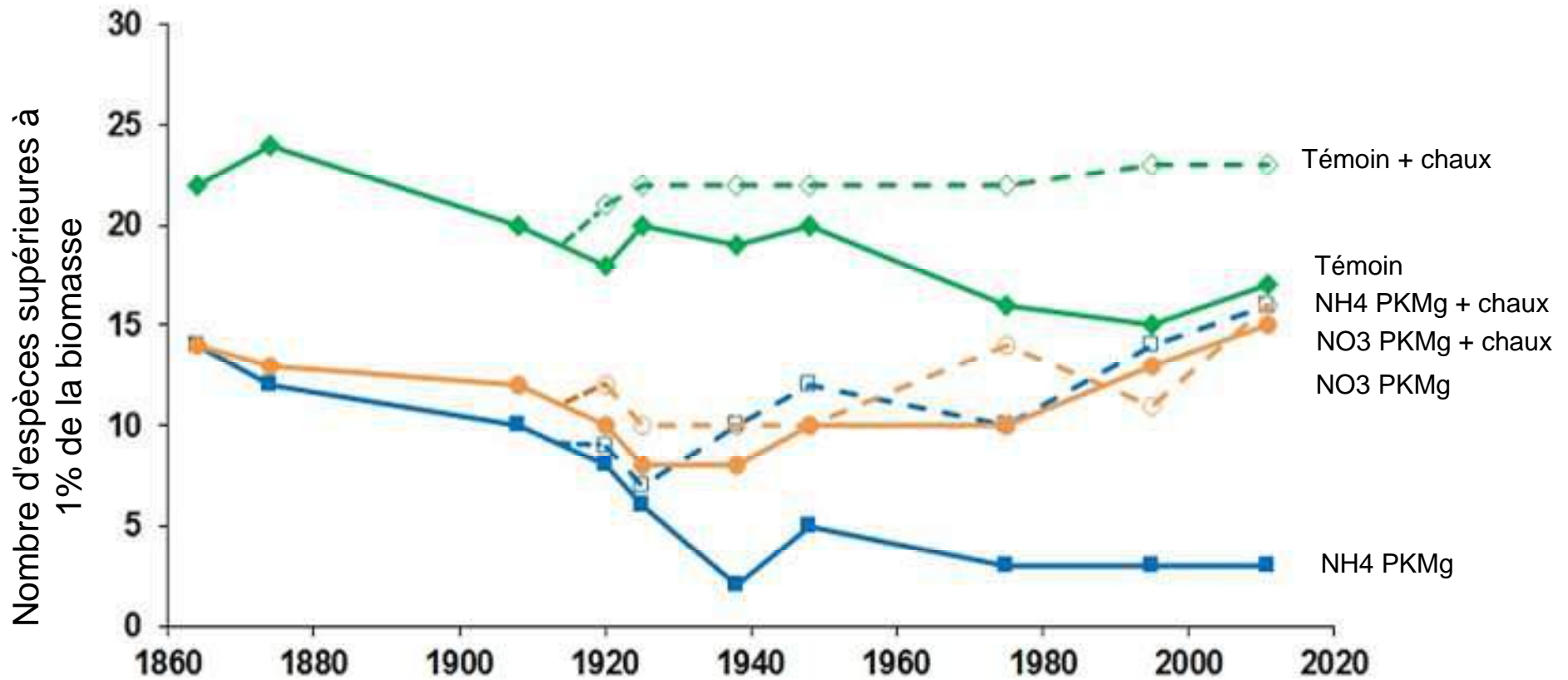
K (0 – 225 kg . ha⁻¹)

P (0 – 35 kg . ha⁻¹)

Chaulage (0 vs entretien)



Essai Park Grass – Diversité spécifique



- ◆ 3 No fertilizer
- ◇ 3 No fertilizer + chalk
- 9 N₂PKNaMg
- 9 N₂PKNaMg + chalk
- 14 N*2PKNaMg
- 14 N*2PKNaMg + chalk

AGRONOMIC PRACTICES

Fertiliser treatments since 1856;

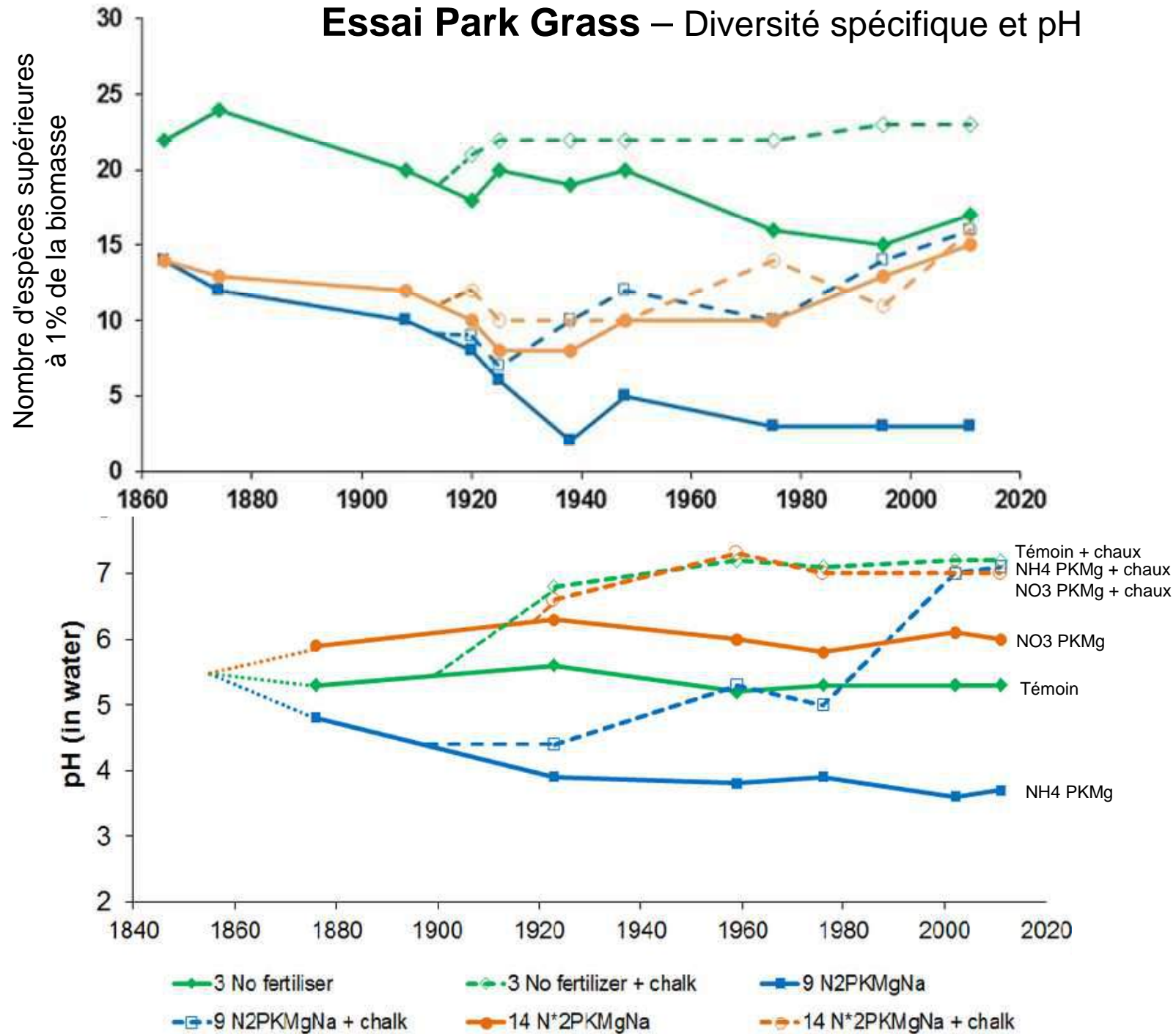
No fertiliser - Plot 3 No fertilizer or manure

N*2PKNaMg - Plot 14: 96kgN as sodium nitrate plus P,K,Na and Mg

N₂PKNaMg - Plot 9: 96kgN as ammonium sulphate plus P, K, Na and Mg

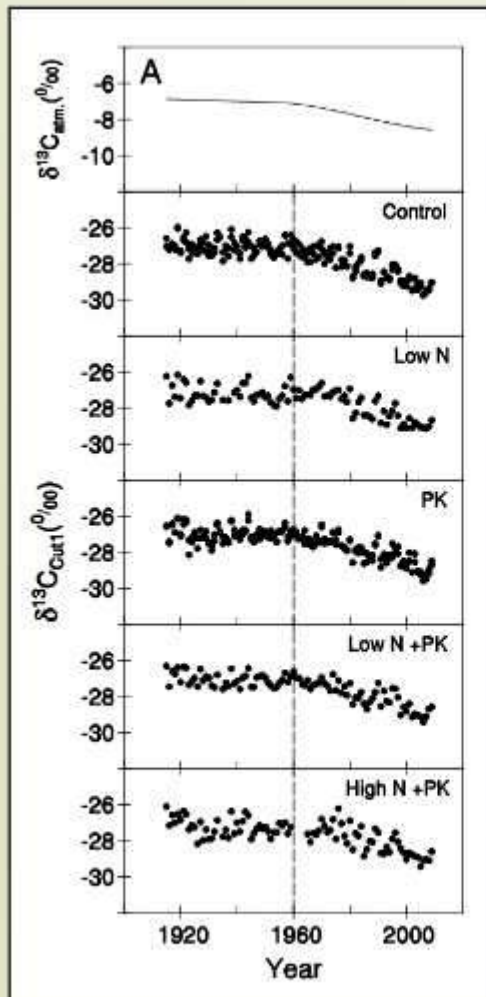
Chalk: Ground chalk (CaCO₃) applied approximately every four years 1903 - 1964 then as required to maintain pH at around 6.

Essai Park Grass – Diversité spécifique et pH



Essai Park Grass – Changement global et efficacité d'utilisation de l'eau

Detecting Changes in Water use Efficiency on Park Grass using Herbage ^{13}C Analyses



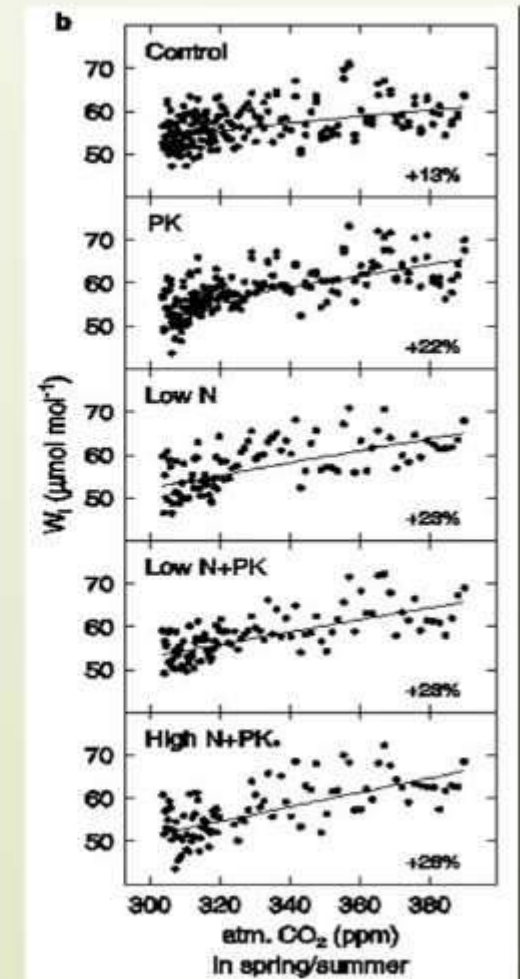
$$W_i = \frac{A}{g_s} = \frac{c_a - c_i}{1.6} = \frac{c_a \left(1 - \frac{a}{c_a}\right)}{1.6}$$

W_i = Intrinsic water-use efficiency
 A = C assimilation rate
 g_s = stomatal conductance

$$^{13}\Delta = \frac{\delta^{13}\text{C}_{\text{atm}} - \delta^{13}\text{C}_{\text{plant}}}{1 + \delta^{13}\text{C}_{\text{atm}}}$$

$$^{13}\Delta = a + (b - a) \cdot \frac{c_i}{c_a}$$

a = fractionation during diffusion in air (4.4‰)
 b = fractionation during CO_2 fixation (27‰)
 c_i = intercellular CO_2 concentration
 c_a = atmospheric CO_2 concentration



Essai Exhaustion Land - Modalités testées

1940 - 1985

Plot 9	Plot 7	Plot 5	Plot 3	Plot 1
N3	N3	N3	N3	N3
N2	N2	N2	N2	N2
(P) (1876-1901)	(NPKNaMg) (1876-1901)	(N) (1876-1901)	(FYM(P)) (1876-1901)	(Ni) (1876-1901)
N1	N1	N1	N1	N1
N0	N0	N0	N0	N0

1993 - 1999

Plot 9	Plot 7	Plot 5	Plot 3	Plot 1
N	N	N	N	N
N	N	N	N	N
(P) (1876-1901)	(NPKNaMg) (1876-1901)	(N) (1876-1901)	(FYM(P)) (1876-1901)	(Ni) (1876-1901)
N	N	N	N	N
N	N	N	N	N

1986 - 1992



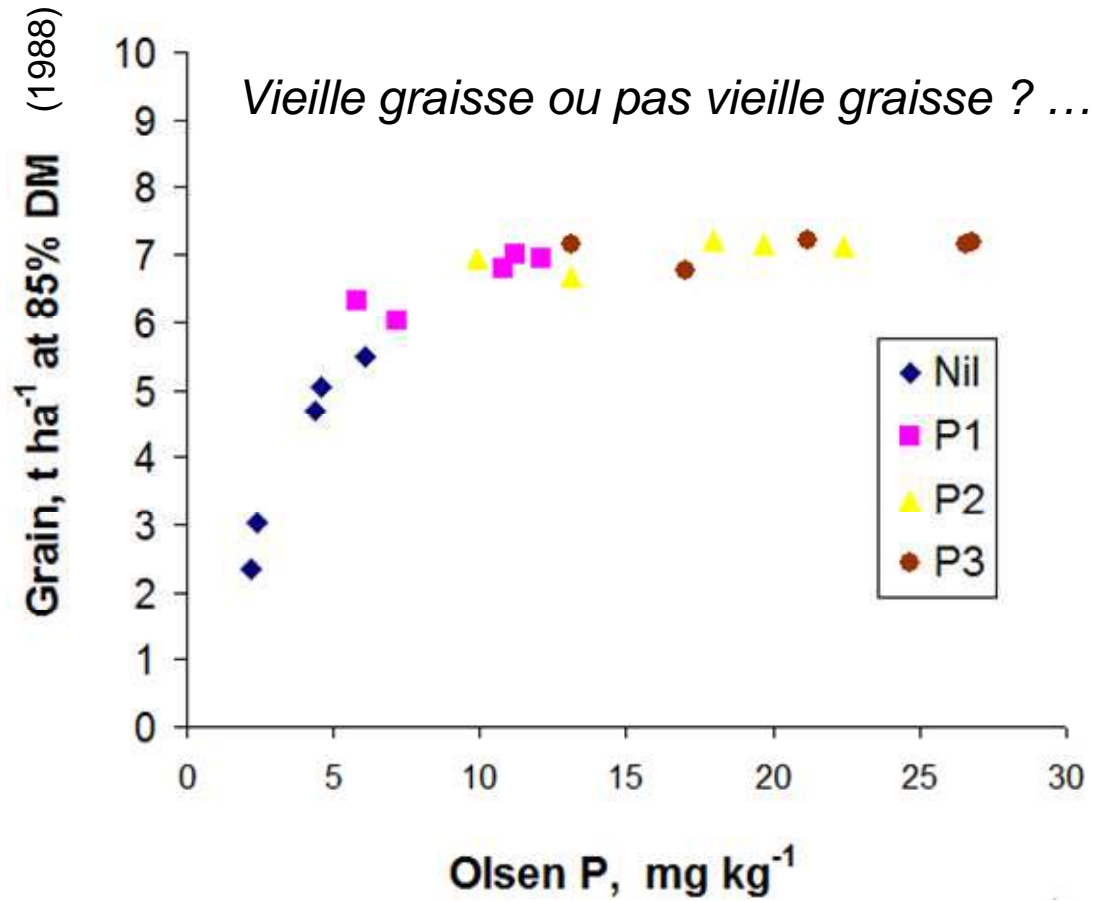
2000 - ...

Plot 9	Plot 7	Plot 5	Plot 3	Plot 1
P : 20 kg				
P : 20 kg				
(P) (1876-1901)	(NPKNaMg) (1876-1901)	(N) (1876-1901)	(FYM(P)) (1876-1901)	(Ni) (1876-1901)
P : 20 kg				
P0 0 kg				

Large contribution à calcul de seuils et de doses ...

Essai Exhaustion Land – Résultats P

Plafonnement des rendements après seulement 3 ans de fertilisation



Essai Exhaustion Land – Résultats P

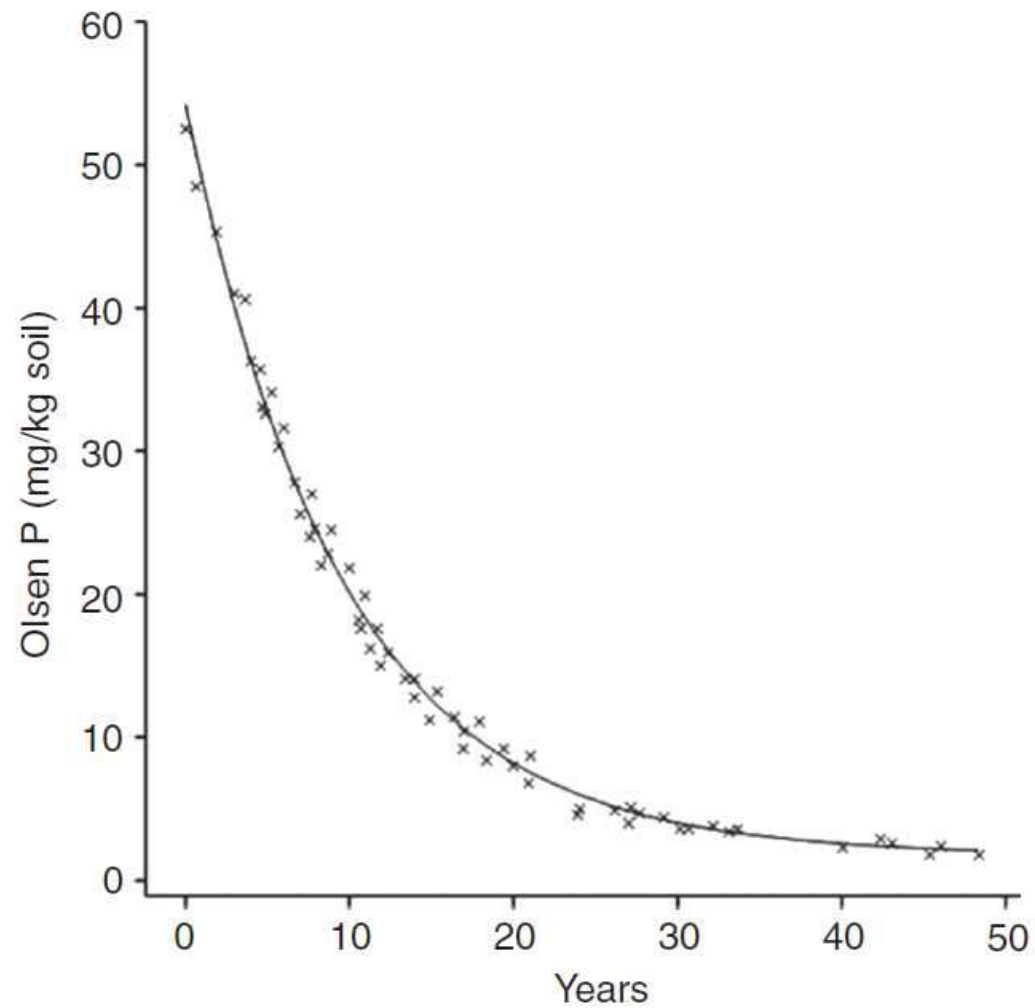
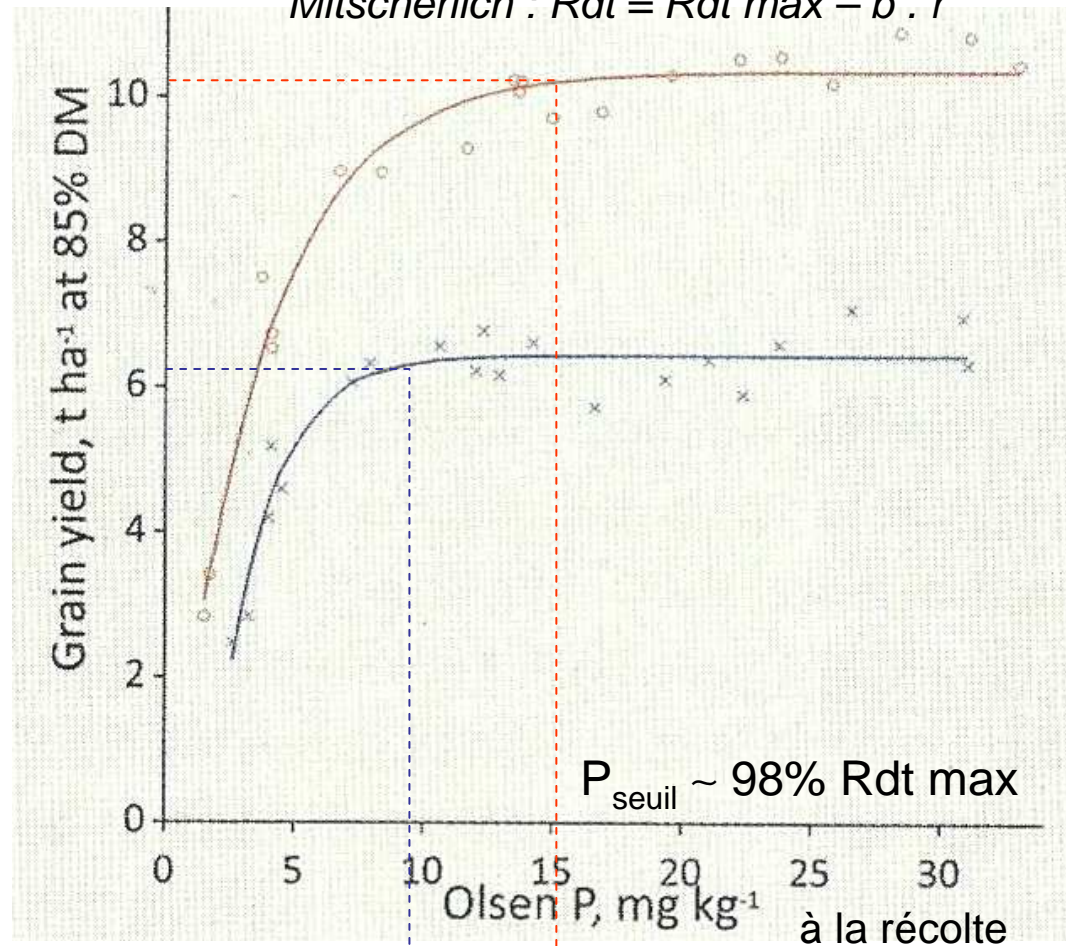


Figure 3 Exhaustion Land: an exponential decay curve fitted to data from soils which received no P from 1993–99 following different amounts of P from 1986 to 1992.

Méthodes de fixations des seuils d'impasse

1 modèle chaque année, pas de calcul d'Indices de rendements

$$\text{Mitscherlich} : Rdt = Rdt \text{ max} - b \cdot r^P$$



Effets climats :
Sécheresses
Maladies
...


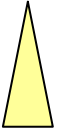






Structure du sol
Qualité lit de semence

Méthodes de fixations des seuils d'impasse – Effets exigences

Harvest year	N applied kg/ha	Fitted asymptotic yield and its standard error		Olsen P at 98% asymp. yield and its SE		Variance accounted for %	
		t/ha	SE	mg/kg	SE		
Potato tubers, t/ha							
1969	250	39.6	0.70	11	} 26	1.8	84
1970	250	29.4	1.35	46		9.7	92
1971	250	51.6	1.42	19		6.2	81
1972	250	42.3	0.88	14		3.5	81
1973	250	41.3	1.67	13		7.8	66
1974	250	54.7	2.87	53		11.8	97
Sugar, from sugar beet, t/ha							
1969	190	8.93	0.137	20	} 22	1.8	97
1970	190	4.02	0.335	30		13.7	61
1971	190	7.59	0.155	19		3.9	90
1972	190	6.38	0.173	28		5.9	91
1973	190	8.39	0.128	14		1.2	99
1974	190	4.79	0.856	– ^a			

Harvest year	N applied kg/ha	Fitted asymptotic yield and its standard error		Olsen P at 98% asymp. yield and its SE		Variance accounted for %	
		t/ha	SE	mg/kg	SE		
Spring barley after potatoes							
1970	125	4.69	0.068	17	} 16	3.5	88
1971	125	4.95	0.083	24		3.9	93
1972	100	5.72	0.113	8		1.6	79
1973	100	4.27	0.504	– ^a			
1974	80	5.44	0.201	15		13.6	48
1975	80	5.39	0.074	17		3.8	95
Spring barley after sugar beet							
1970	125	4.38	0.086	26	} 18	5.5	91
1971	125	4.69	0.090	19		2.5	93
1972	100	5.73	0.106	14		3.4	83
1973	100	5.22	0.068	8		1.0	95
1974	80	5.21	0.097	25		4.5	97
1975	80	– ^a		– ^a			

















Méthodes de fixations des seuils d'impasse – Effets nutrition N

<i>Blé hiver</i>		Fitted asymptotic yield and its standard error		Olsen P at 98% asymp. yield and its SE		Variance accounted for %
		N applied kg/ha	t/ha	SE	mg/kg	
1978	 40	 6.63	0.176	 19	3.6	64
	80	8.04	0.138	16	2.4	84
	120	8.10	0.125	11	1.5	80
	160	8.27	0.175	12	3.7	44
1979	 40	 4.42	0.182	 23	12.8	42
	80	5.89	0.266	27	14.7	44
	120	6.46	2.520	12	2.0	76
	160	6.53	0.111	7	0.7	71
1980	 40	 6.12	0.288	24	12.7	34
	80	8.85	2.140	– ^a		
	120	7.98	0.175	7	2.0	56
	160	9.22	0.278	21	6.4	64

Essai Saxmundham, Suffolk, 1978-1979

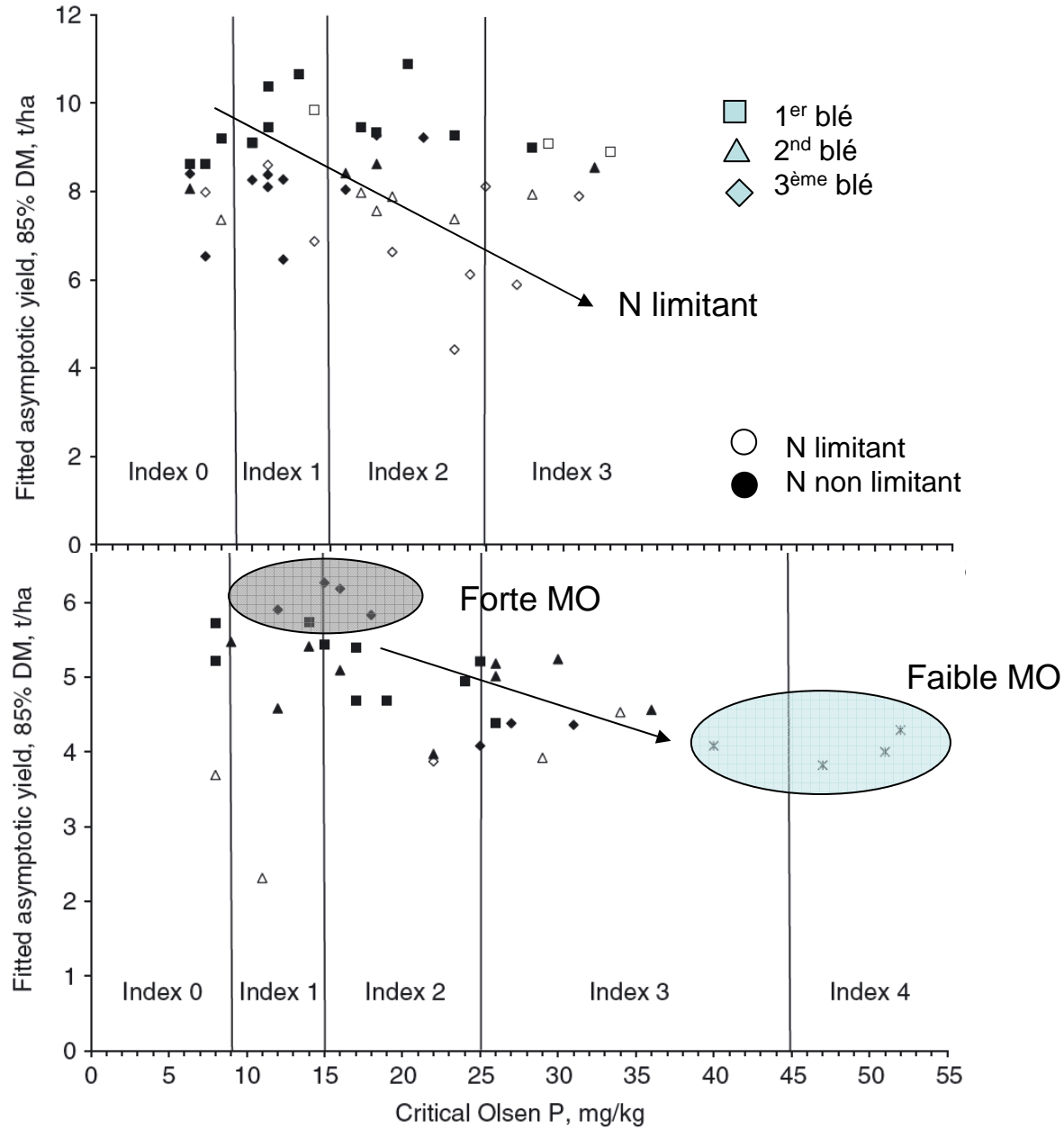
Johnston et al. 2013

Méthodes de fixations des seuils d'impasse – Effets MO

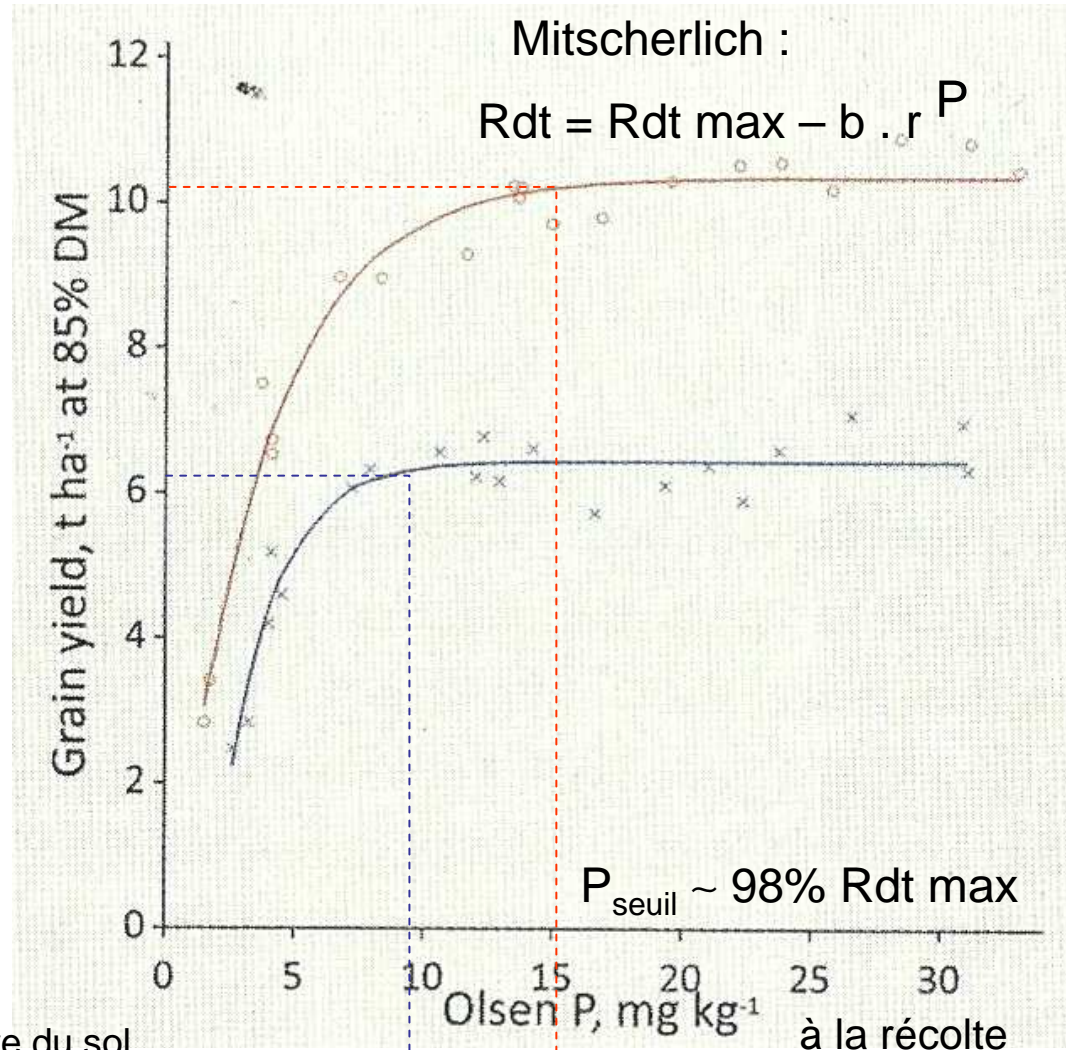
Crop	Soil organic matter %	Fitted asymptotic yield	Olsen P at 95% asymp. yield mg/kg	Variance accounted for %
Field experiment				
Spring barley, grain, t/ha	2.4 	5.26	16 	83
	1.5 	4.69	45 	46
Potatoes, tubers, t/ha	2.4 	47.1	17 	89
	1.5 	46.5	61 	72
Sugar beet, sugar, t/ha	2.4 	6.92	18 	87
	1.5 	6.91	32 	61
Pot experiment				
Grass, dry matter, g/pot	2.4 	6.80 ^a	23 	96
	1.5 	6.85	25 	82

^aThe response curves at the two levels of soil organic matter were not visually different.

Méthodes de fixations des seuils d'impasse – Vue synthétique



Méthodes de fixations des seuils d'impasse – Facteurs d'influence



Effets climats :
Sécheresses
Maladies
...

Structure du sol
Qualité lit de semence
Quantité de MO dans le sol
Interactions avec N
Exigence des cultures

Accéder à la base de données des essais de RR

The e-RA database contains data on crop yield, soils, species diversity and weather relating to Rothamsted and the Long-term Experiments:

- Broadbalk (from 1844)
- Park Grass (from 1856)
- Hoosfield Barley (from 1852)
- The Alternate Wheat and Fallow (from 1856)
- Meteorological data for Rothamsted (from 1853), Woburn (from 1928) and Brooms Barn (from 1982)



The e-RA website includes:

- A comprehensive searchable bibliography – >1000 publications.
- Extensive background information – cropping plans, fertilizer rates, etc
- Case studies – examples of recent uses of the LTE data
- Dedicated schools webpage with access to selected Rothamsted met data
- Open Access data, including:-
 - Broadbalk Yields
 - Park Grass Species Diversity
 - Annual mean Rothamsted temperature
 - Broadbalk Soil Organic Carbon
 - Hoosfield Soil Organic Carbon

Accéder à la base de données des essais de RR

The screenshot shows the e-RA website interface. At the top, there is a navigation bar with the e-RA logo and the text "e-RA: the electronic Rothamsted Archive". Below this is a search bar and a navigation menu with links such as Home, News, Extract Data, Data Extraction Tool, Open Access, Broadbalk, Park Grass, Hoosfield Barley, Alternate Wheat and Fallow, Wilderness Experiments, Exhaustion Land, Rothamsted Ley Arable, Woburn Ley Arable, Woburn Farm, Met Data, Other Long Term Experiments, Data Extraction Tool, Case studies, Schools, Sample Archive, Insect Survey, North Wyke Farm Platform, Search Bibliography, Reports in eRAdoc, Soil Map, Disclaimer, Data Quality, and Credits and Contact.

Welcome to e-RA, the *electronic* Rothamsted Archive.

Contact the e-RA Curators to arrange a password for the database.

e-RA provides a permanent managed database for secure storage of data from Rothamsted's Long-term Experiments, the oldest, continuous agronomic experiments in the world. Together with the accompanying meteorological records, associated documentation and sample archive, it is a unique historical record of experiments that have been measured continuously for over 170 years. Users have access to experimental data and specialist background information on the effects of agricultural practices on crops, soils and associated ecosystems.

Currently, e-RA holds records of yields, species composition and other data for the following Long-term experiments:

Crop	Experiment	Year started
Winter wheat (and other arable crops in rotation since 1968)	Broadbalk	1843
Permanent grassland	Park Grass	1856
Spring barley	Hoosfield Barley	1852
Winter wheat	Alternate Wheat & Fallow	1856-2015
Woodland	Geescroft & Broadbalk Wilderness	1880s
Ley Arable rotations	Woburn Ley-Arable Experiment	1938

Meteorological data for Rothamsted (from 1853), Woburn (from 1928) and Brooms Barn (from 1982) are also available.

- [Extract Data](#) shows the current datasets.
- The links (left) lead to background information on the experiments.
- The searchable [Bibliography](#) lists over 1400 publications connected with the experiments.

The data in e-RA are available for scientific research, but remain the property of Rothamsted Research and the Lawes Agricultural Trust. Most of the data are password-protected and access is subject to our [Data Access Policy](#).

The [Open Access](#) data are available to all, no password is required, although we ask that users acknowledge Rothamsted Research as the data source.

Please contact the e-RA Curators to arrange a password, for further information, or to extract data on your behalf.

The e-RA database is part of the Long-term Experiments National Capability, which also includes the Long-Term Experiments, the [Sample Archive](#) and the Environmental Change Network. It is jointly funded by the BBSRC and the Lawes Agricultural Trust.

[Downloadable brochure on e-RA.](#)

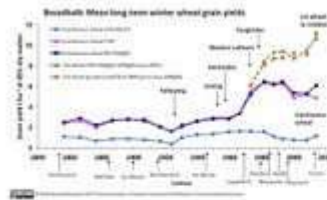
[History of Rothamsted](#) including a timeline of the life and work of Sir John Bennet Lawes.

For information on the history, development and uses of e-RA see **"The electronic Rothamsted Archive (e-RA), an online resource for data from the Rothamsted long-term experiments"** by Perryman et al, 2018 published online in the Nature Scientific Data collection of special articles on **"Open research data resources"** May 2018. See also [press release](#).

Accéder à la base de données des essais de RR

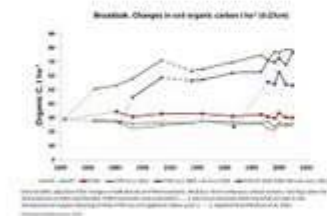
Broadbalk Wheat:

Broadbalk Yields



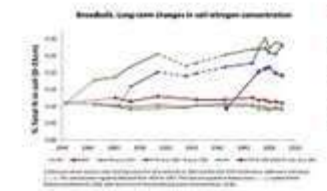
Mean long-term winter wheat yields from selected treatments on Broadbalk are shown. The changes reflect the improved cultivars, cultivations and control of pests, diseases and weeds that have been introduced on Broadbalk, especially since the 1960s. Yields of continuous wheat given no fertilizer or manure have remained at around 1 t ha⁻¹. Since 1979 summer fungicides have been used, which has allowed us to exploit the greater grain yield potential of modern cultivars. In 1968 a rotation was introduced on part of the experiment, so that it is now possible to compare the yields of wheat grown continuously and as the first wheat after a two year break. The highest yields are now from the first wheat crop in rotation, with the best yields from fertilizer alone exceeding those from FYM alone, and the combination of FYM + 96 kgN ha⁻¹ (144 kgN ha⁻¹ since 2005) often exceeding both.

Broadbalk Soil Organic Carbon



Changes in soil organic carbon (SOC) content in selected treatments of the Broadbalk experiment, where winter wheat has been grown each year since autumn 1843. SOC (0-23cm) has remained almost constant in the unfertilized plot, at the equilibrium level for this farming system on this soil type. Inorganic fertilizer (NPK) has enhanced SOC a little, probably due to increased returns of organic matter in crop roots and residues. The treatment given 35 t ha⁻¹ FYM now contains almost three times as much SOC as the unfertilized plot. Increases were greatest in the initial years of the experiment.

Broadbalk Soil Total Nitrogen



Changes in soil total nitrogen (N) concentration (%) in selected treatments of the Broadbalk experiment, where winter wheat has been grown each year since autumn 1843. Soil % N (0-23cm) has remained almost constant in the unfertilized plot. Inorganic fertilizer with nitrogen (NPK) has enhanced %N a little, probably due to increased returns of organic matter in crop roots and residues. The treatment given 35 t ha⁻¹ FYM now has about three times the concentration of soil % N as the unfertilized plot. Increases were greatest in the initial years of the experiment.

Accéder à la base de données des essais de RR

Data Access Policy – Classical and Long Term Experiments

Request for data from e-RA



Please complete details of applicant requesting the data after reading principles and conditions at end of this document:

Name	JORDAN-MEILLE Lionel
email	lionel.jordan-meille@agro-bordeaux.fr
Date	
Institute/University/ Organisation Name	High school : Bordeaux Science Agro Research laboratory : Institut National de Recherche Agronomique (INRA). France.
Institute/University/ Organisation Address	1 cours du Général de Gaulle. 33175 Gradignan CS 40201 FRANCE
Brief description of Institute/University/ Organisation	Classes given in an high school for agronomy National institute of agronomy

Names of Rothamsted Research staff (if any) that are collaborating in the data request:

Department for Sustainable Agriculture Sciences
Dr Stephan Haefele

Scientific Case for Obtaining Data

Brief details of the research project that the data will be used for, including the project title, the hypothesis being tested, and the data analyses that will be performed:

Details of the Data Requested

Give details of what data will be required, including which experiment(s), years and plots/treatments:

Exhaustion land
Soil available P

I request access to data from the e-Rothamsted Archive 'e-RA'. I agree that the copyright and database rights for this information are vested in the owner as specified on the e-RA web site. I agree not make the data available to any third party, or publish any part of the data in any form either physical or electronic without first obtaining the approval of Rothamsted Research. I agree that I will acknowledge Rothamsted Research as the owner of the data in any publication that arises from their use. I will take all precautions necessary to ensure that the data are safeguarded against unauthorised access and/or use by any other person. My authority to use the data will terminate on a date four years from the date of my signature of this declaration and I will not retain any copy of the data after this date. Subsequent use of this data shall be conditional upon a request to renew access to the data. This declaration shall be subject to and construed and interpreted according to the Law of England.

We will keep your request details in our Access database to monitor usage of our data which is valuable for reports to funders and in bids for continuation of funding.

If you do not wish your contact details to be kept please tick this box

Tuesday, the 13th February 2019
L. JORDAN-MEILLE

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Accéder à la base de données des essais de RR

registering or to [reset your password](#).' The footer includes the Rothamsted Research logo and the tagline 'where knowledge grows'."/>

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– then –
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Order by dataset name Show Help

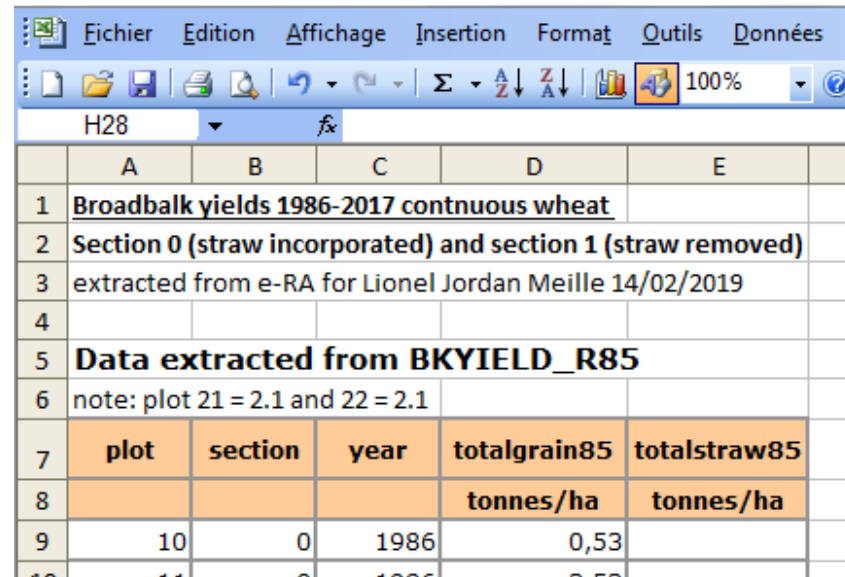
Dataset	Description
Broadbalk Experiment	
<input type="checkbox"/> BKYIELD	Broadbalk wheat yields 1844-1925
<input type="checkbox"/> BKYIELD_F	Broadbalk wheat yields 1926-1953
<input type="checkbox"/> BKYIELD_F85	Broadbalk wheat yields 1954-1967
<input type="checkbox"/> BKYIELD_R85	Broadbalk wheat yields 1968-Current Year
<input type="checkbox"/> BKBEANS	Broadbalk beans yields 1968-1978
<input type="checkbox"/> BKFMAIZE	Broadbalk maize yields 1997-2017
<input type="checkbox"/> BKOATS	Broadbalk oats yields 1996-2017
<input type="checkbox"/> BKPOTATO	Broadbalk potato yields 1968-1996
<input type="checkbox"/> BKWHNUTRI	Broadbalk wheat crop nutrient data 1968-2013
<input type="checkbox"/> BKOATNUTRI	Broadbalk oat crop nutrient data 1996-2013
<input type="checkbox"/> BKBEANNUTRI	Broadbalk beans crop nutrient data 1968-1978
<input type="checkbox"/> BKMAIZNUTRI	Broadbalk maize crop nutrient data 1997-2013
<input type="checkbox"/> BKPOTSNUTRI	Broadbalk potato crop nutrient data 1968-96
<input type="checkbox"/> BKWEEDS_FAL	Broadbalk weed surveys 1933-1967
<input type="checkbox"/> BKWEEDS_ROT	Broadbalk weed surveys 1968-1979
<input type="checkbox"/> BKWEEDS_SUM	Broadbalk weed surveys summary 1991-2018
Meteorological Records - click for important met data corrections and updates	
<input type="checkbox"/> BROOMET	Brooms Barn meteorological records 1982-Current Date
<input type="checkbox"/> ROTHMET	Rothamsted meteorological records 1853-Current Date
<input type="checkbox"/> WOBMET	Woburn meteorological records 1928-Current Date
<input type="checkbox"/> SCHOOLMETDAY	Daily Rothamsted weather data for schools 1990-Current Date
<input type="checkbox"/> SCHOOLMETMTH	Monthly Rothamsted weather data for schools 1878-2013
<input type="checkbox"/> PUBLICDAYMET	Public Rothamsted meteorological records 1918-Current Date

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Fichier Edition Affichage Insertion Format Outils Données					
H28 fx 100%					
	A	B	C	D	E
1	Broadbalk yields 1986-2017 continuous wheat				
2	Section 0 (straw incorporated) and section 1 (straw removed)				
3	extracted from e-RA for Lionel Jordan Meille 14/02/2019				
4					
5	Data extracted from BKYIELD_R85				
6	note: plot 21 = 2.1 and 22 = 2.1				
7	plot	section	year	totalgrain85	totalstraw85
8				tonnes/ha	tonnes/ha
9	10	0	1986	0,53	
10	11	0	1986	3,53	
11	12	0	1986	4,55	
12	13	0	1986	4,35	
13	14	0	1986	4,68	
14	15	0	1986	4,43	
15	16	0	1986	4,55	
16	17	0	1986	4,77	
17	18	0	1986	4,06	
18	19	0	1986	1,96	
19	20	0	1986	0,38	
20	21	0	1986	5,7	
21	22	0	1986	4,9	
22	3	0	1986	1,44	
23	5	0	1986	1,78	
24	6	0	1986	3,24	
25	7	0	1986	4,52	
26	8	0	1986	5,05	

Accéder à la base de données des essais de RR



The screenshot shows an Excel spreadsheet with the following content:

	A	B	C	D	E
1	Broadbalk yields 1986-2017 continuous wheat				
2	Section 0 (straw incorporated) and section 1 (straw removed)				
3	extracted from e-RA for Lionel Jordan Meille 14/02/2019				
4					
5	Data extracted from BKYIELD_R85				
6	note: plot 21 = 2.1 and 22 = 2.1				
7	plot	section	year	totalgrain85	totalstraw85
8				tonnes/ha	tonnes/ha
9	10	0	1986	0,53	
10	11	0	1986	0,53	

**FAIR data principles to make the data
"Findable, Accessible, Interoperable and Re-usable"**

15	16	0	1986	4,55
16	17	0	1986	4,77
17	18	0	1986	4,06
18	19	0	1986	1,96
19	20	0	1986	0,38
20	21	0	1986	5,7
21	22	0	1986	4,9
22	3	0	1986	1,44
23	5	0	1986	1,78
24	6	0	1986	3,24
25	7	0	1986	4,52
26	8	0	1986	5,05

Rothamsted Research : articles principaux cités

Heckrath, G. , Brookes, P. C. , Poulton, P. R. and Goulding, K. W. T. (1995) "Phosphorus Leaching from Soils Containing Different Phosphorus Concentrations in the Broadbalk Experiment", *Journal of Environmental Quality*, **24**, (5), 904-910
DOI: [doi:10.2134/jeq1995.00472425002400050018x](https://doi.org/10.2134/jeq1995.00472425002400050018x) (Journal Article)

Poulton, P. R. , Johnston, A. E. and White, R. P. (2013) "Plant-available soil phosphorus. Part I: the response of winter wheat and spring barley to Olsen P on a silty clay loam", *Soil Use and Management*, **29**, (1), 4-11
DOI: [10.1111/j.1475-2743.2012.00450.x](https://doi.org/10.1111/j.1475-2743.2012.00450.x) (Journal Article)

Johnston, A. E. , Poulton, P. R. , White, R. P. and Macdonald, A. J. (2016) "Determining the longer term decline in plant-available soil phosphorus from short-term measured values", *Soil Use and Management*, **32**, 151-161
DOI: [10.1111/sum.12253](https://doi.org/10.1111/sum.12253) (Journal Article)

Johnston, A. E. , Poulton, P. R. and White, R. P. (2013) "Plant-available soil phosphorus. Part II: the response of arable crops to Olsen P on a sandy clay loam and a silty clay loam", *Soil Use and Management*, **29**, (1), 12-21
DOI: [10.1111/j.1475-2743.2012.00449.x](https://doi.org/10.1111/j.1475-2743.2012.00449.x) (Journal Article)