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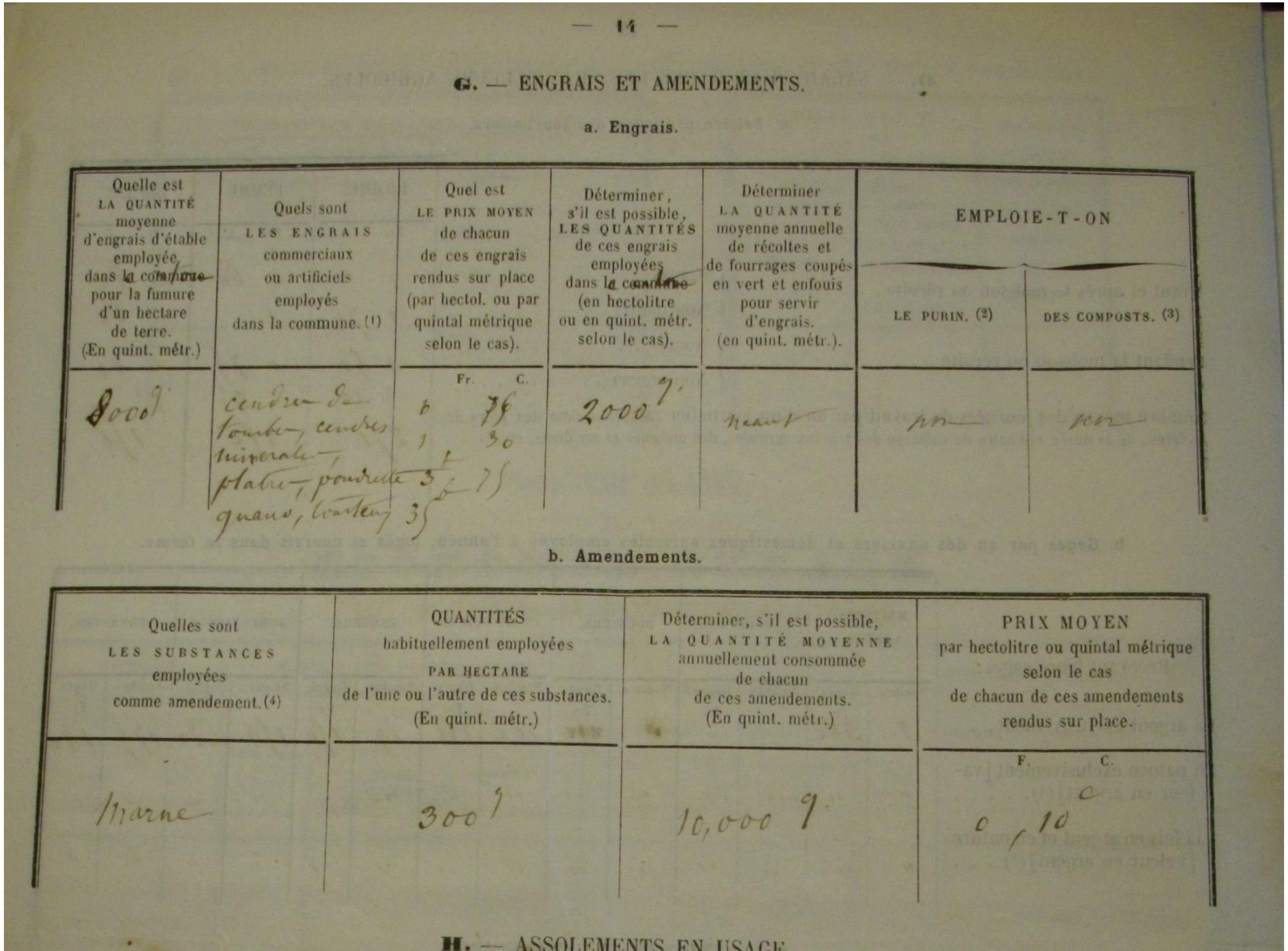
Laurent Herment (CNRS, EHESS/CRH, France)
Eric Mermet (CNRS, EHESS/CAMS, France)

AgrariaTn System and Use of Fertilizers in the 19th Century in France

Introduction

- For several years the topic of the uses of fertilizers, and of agricultural modernisation, became a major concerns in a lot of country.
- Despite this new concerns, the emergence of commercial fertilizers (chemical, organic, mineral, etc.) in Europe are not well studied from an agrarian point of view. With some exception, works about fertilizers usually come from sciences, environment, business and urban historians.
- Our purpose in this communication is to assess the used of fertilizers at the middle of the nineteenth century. This work is a second step in the use of a unique set of information provide by French administration but not published until up now: the agricultural survey of 1862 in which local authorities gave the name of commercial fertilizers usually used in their vicinity (see Herment and Mermet 2018). It is important to underline that we do not know the quantity of fertilisers that are used, but their name.

About the data / agricultural survey of 1862. Due to the structure of answers we have to considered mention of use of fertilizers as qualitative data.



G. — ENGRAIS ET AMENDEMENTS.

a. Engrais.

Quelle est LA QUANTITÉ moyenne d'engrais d'étable employée dans la commune pour la fumure d'un hectare de terre. (En quint. métr.)	Quels sont LES ENGRAIS commerciaux ou artificiels employés dans la commune. (1)	Quel est LE PRIX MOYEN de chacun de ces engrais rendus sur place (par hectol. ou par quintal métrique selon le cas). Fr. C.	Déterminer, s'il est possible, LES QUANTITÉS de ces engrais employées dans la commune (en hectolitre ou en quint. métr. selon le cas).	Déterminer LA QUANTITÉ moyenne annuelle de récoltes et de fourrages coupés en vert et enfouis pour servir d'engrais. (en quint. métr.).	EMPLOIE-T-ON LE PURIN. (2)	EMPLOIE-T-ON DES COMPOSTS. (3)
8000 q	cendres de tourbe, cendres minérales, platre, poudrette, guano, tourteaux	6 75 1 30 3 75 35	2000 q.	néant	non	non

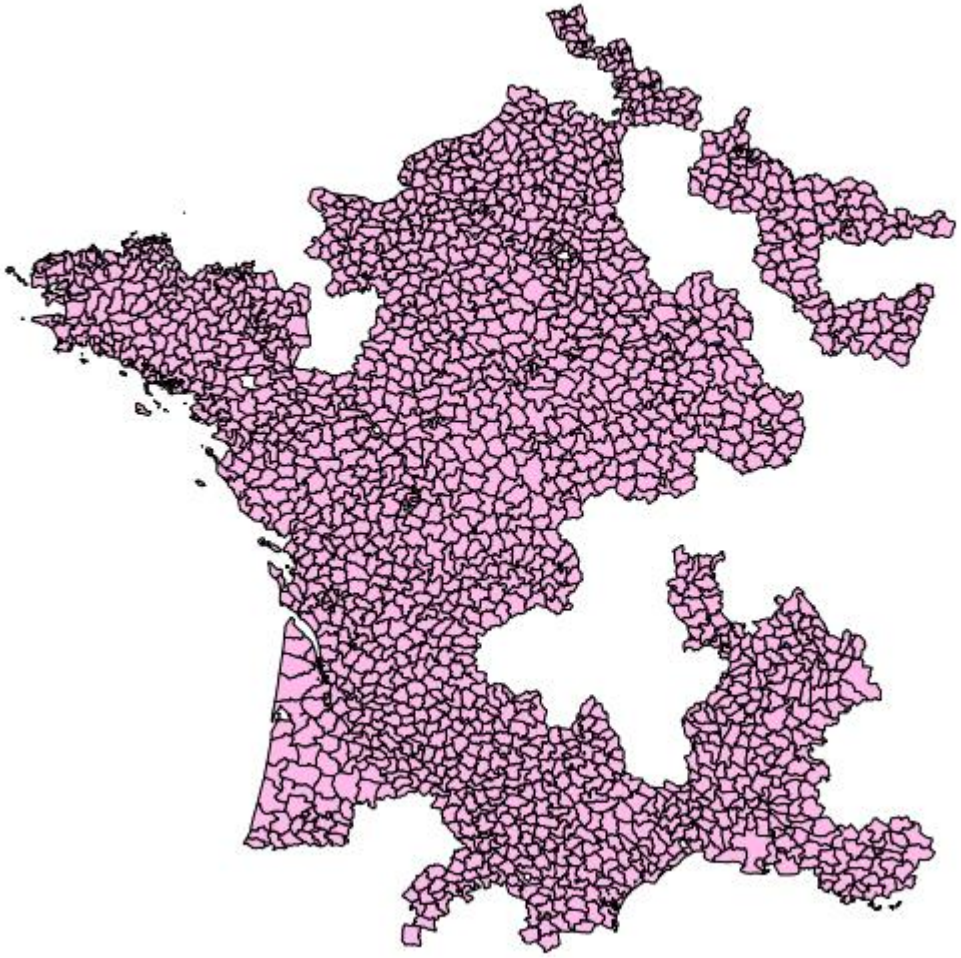
b. Amendements.

Quelles sont LES SUBSTANCES employées comme amendement. (4)	QUANTITÉS habituellement employées PAR HECTARE de l'une ou l'autre de ces substances. (En quint. métr.)	Déterminer, s'il est possible, LA QUANTITÉ MOYENNE annuellement consommée de chacun de ces amendements. (En quint. métr.)	PRIX MOYEN par hectolitre ou quintal métrique selon le cas de chacun de ces amendements rendus sur place. F. C.
Marne	300 q	10,000 q	0, 10 c

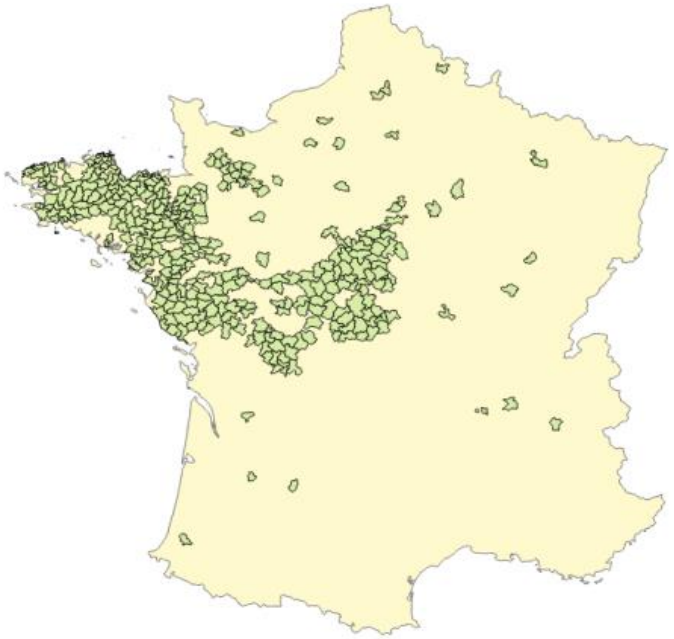
H. — ASSOLEMENTS EN USAGE

Reconstitution of cantons in 1862

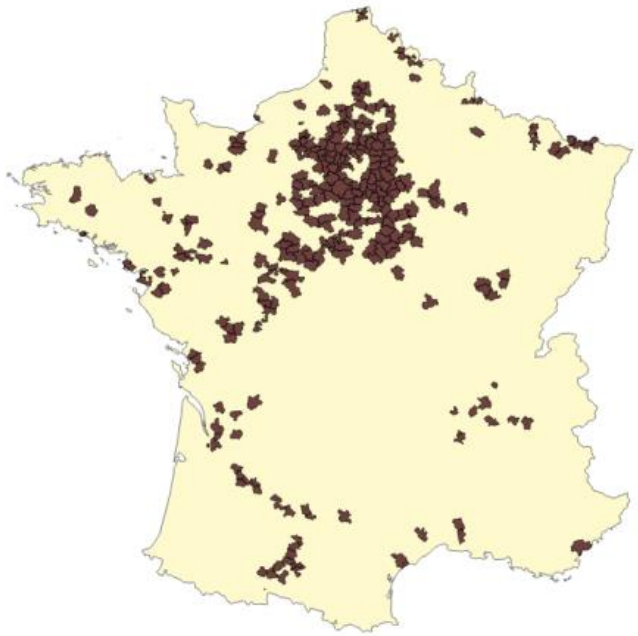
- For now we reconstitute 1915 cantons but some data are missing. Then we have data for 1846 cantons.
- For crops we have for now data for 9 departements in Lorraine (2 departements), Brittany (3 departements) and Paris Bassin (4 departements).



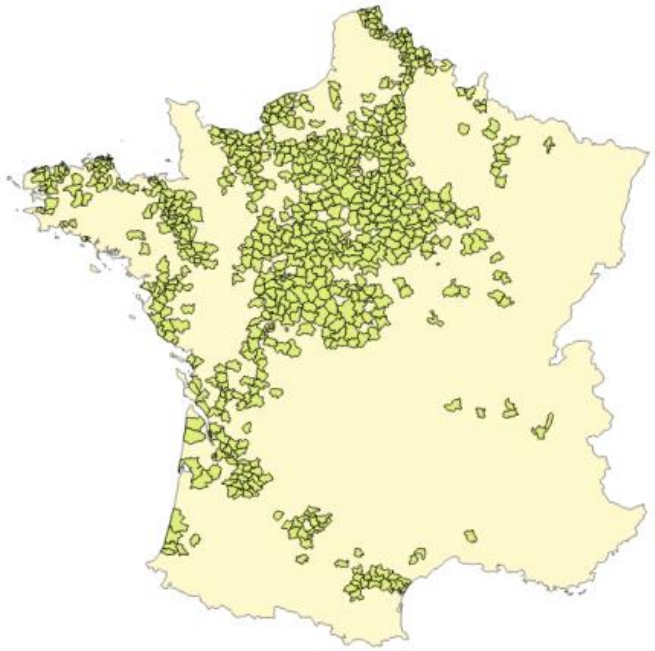
About the data – presence of 3 fertilisers (Herment et Mermet 2018)
We can see on this map that « noir animal » (carbonised bones) were widely used in Brittany while guano was used mainly in the coastal region.



Presence of noir animal

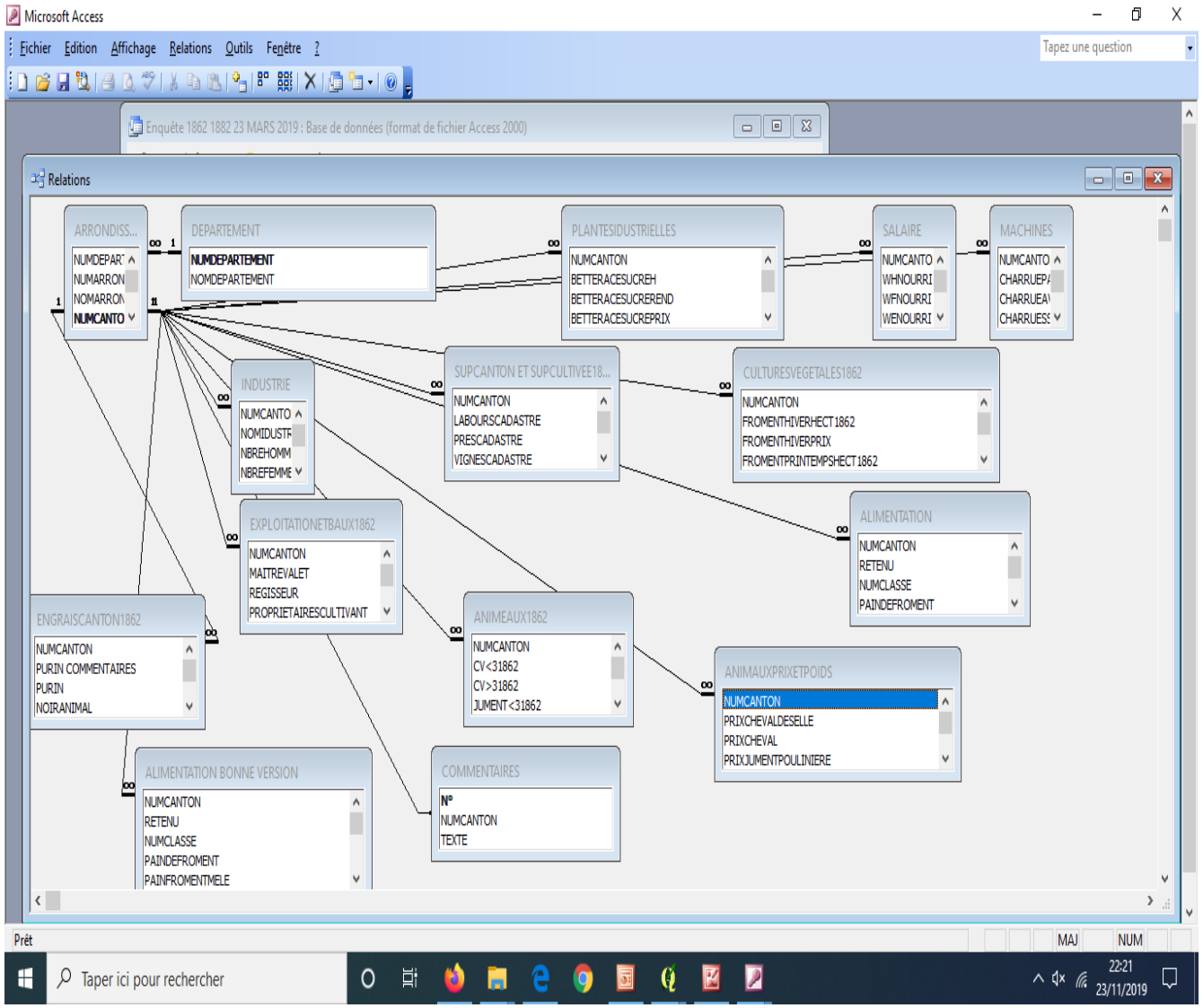


Presence of poudrette



Presence of guano

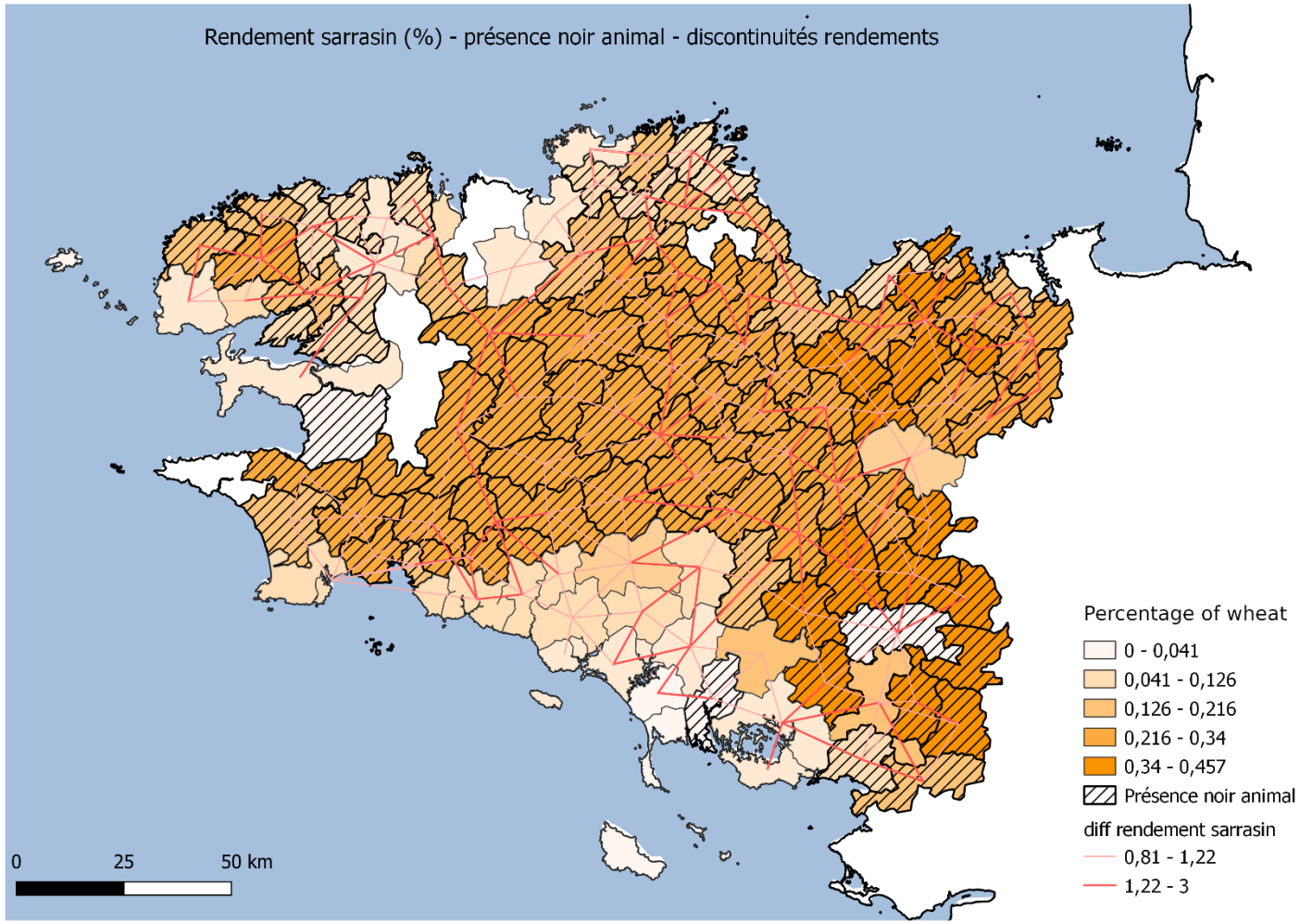
- With all the information gathered in the database we can assess the logic of the use of fertilizers in several region, but also venture some hypothesis about the fact that some organic (i.e. not mineral or chemical) fertilizers were not used in several region.
- In the following section we first analysed the use of fertilizer in association with buckwheat and wheat in Brittany with the help of GIS
- In the second part we used logistic model to better illlustrate the complexity of the use of fertilizes in the agrarian system,

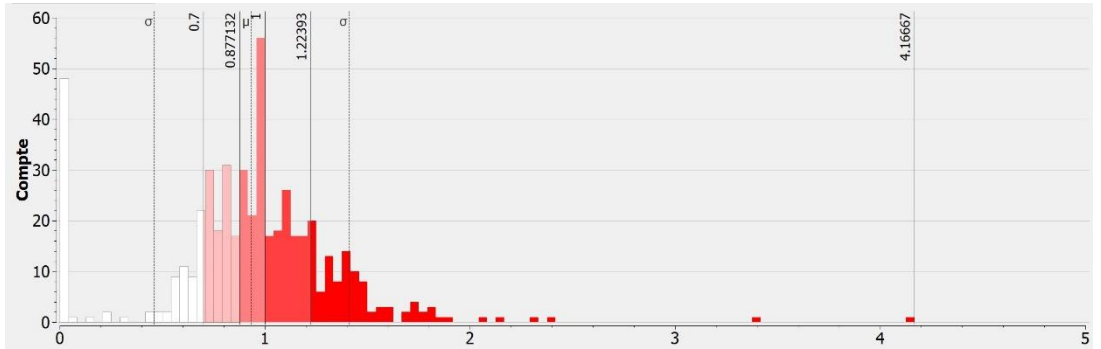


I Buckwheat and fertilizers.

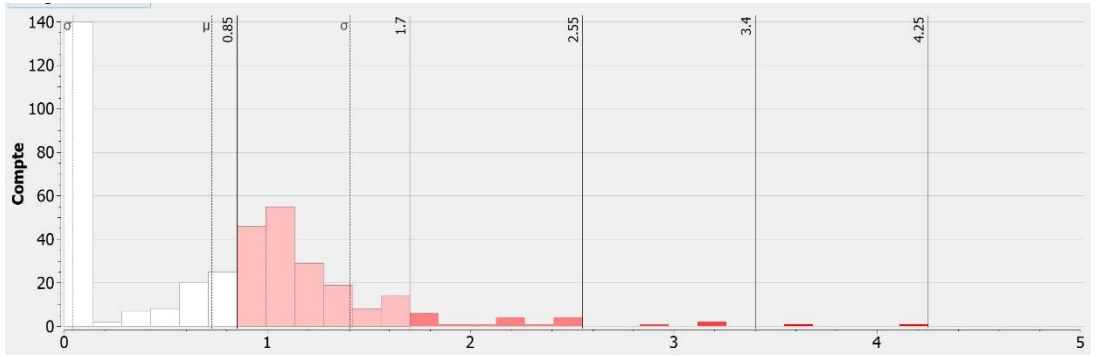
- It seems quite oddly to study the introduction of commercial fertilizers throug the buckwheat. This plant was supposed to be a crop for poor people and backward agriculture in nineteenth century France.
- In fact, the first commercial fertilizer widely used in France was « noir animal », carbonised bones used by sugar refinery to whitened sugar.
- After their use by sugar reffineries, they were sold to farmers. They came from Nantes which was the main port for colonial sugar since the 18 century. Paris Bassin was the second center of production with Picardy and North of France. They were mainly trade in western France, especially in Brittany.
- There are a lot contemporary evidence that proved that this practice was linked with the farming of buckwheat, even if during almost 20 years scientific elites could not explain why it worked (Bobierre 1858, Bourrigaud 1994, Herment 2021). Moreover agrarian elites were not interested by buckwheat, but by sugarbeets and wheat. For elites, buckwheat (and thus « noir animal » did not deserve attention).
- In this first part, we used spatial analyse to better assess the significance of discontinuities of the importance of buckwheat in crop rotation gave by the local anwsers and analyse the link wth the « noir animal ».

Here, it is clear that the presence of “noir animal” (phosphate fertilizer) is directly correlated with the place of buckwheat in crop rotation (share of buckwheat in crop rotation). We can observe a very clear frontier effect in the North and the South of Brittany where the presence of “noir” seems to disappear. At the same time, the neighborhood links of discontinuities diminished.



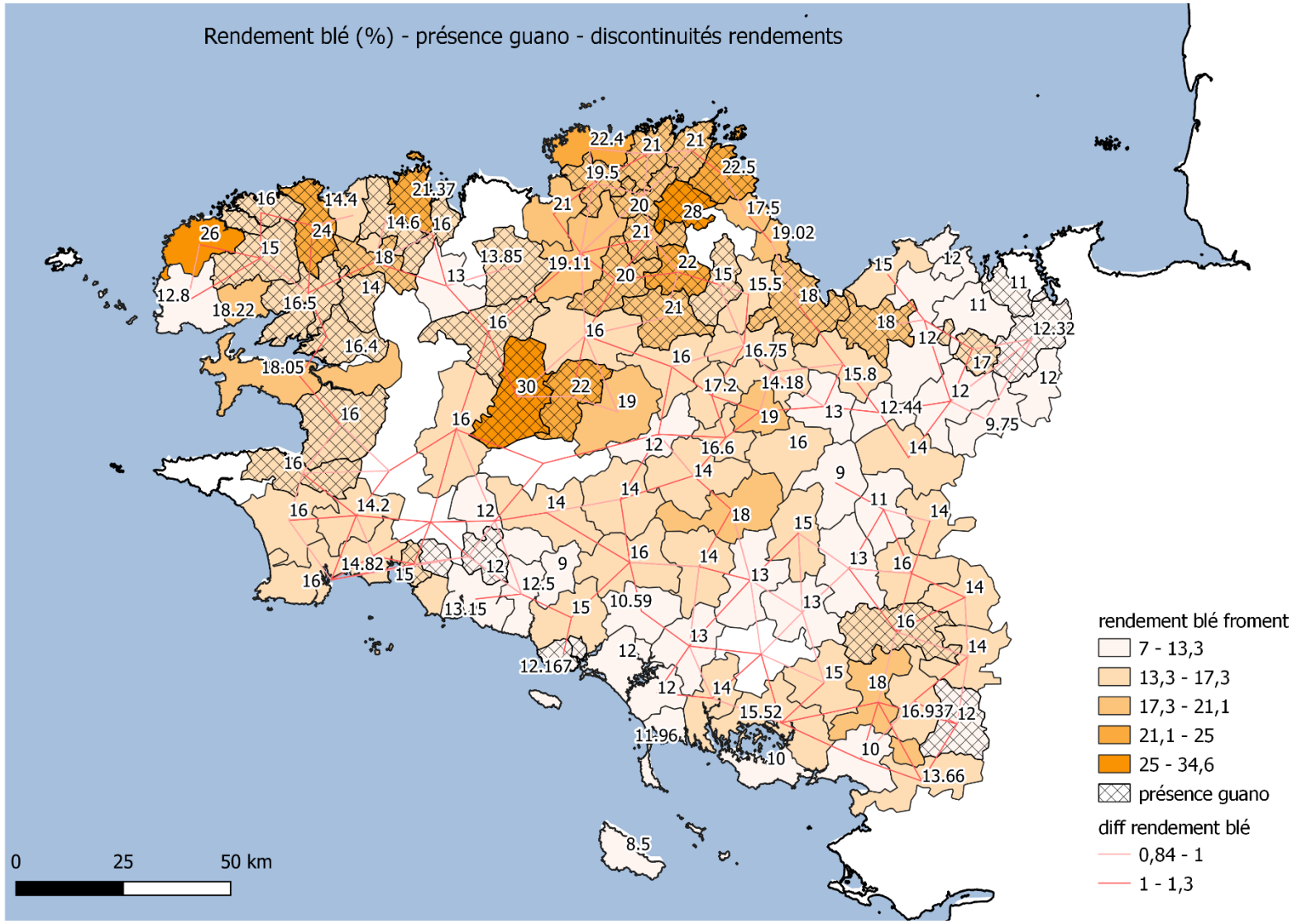


Distribution analysis show that there is less discontinuity where noir animal fertiliser is present (mean is closed to 1)

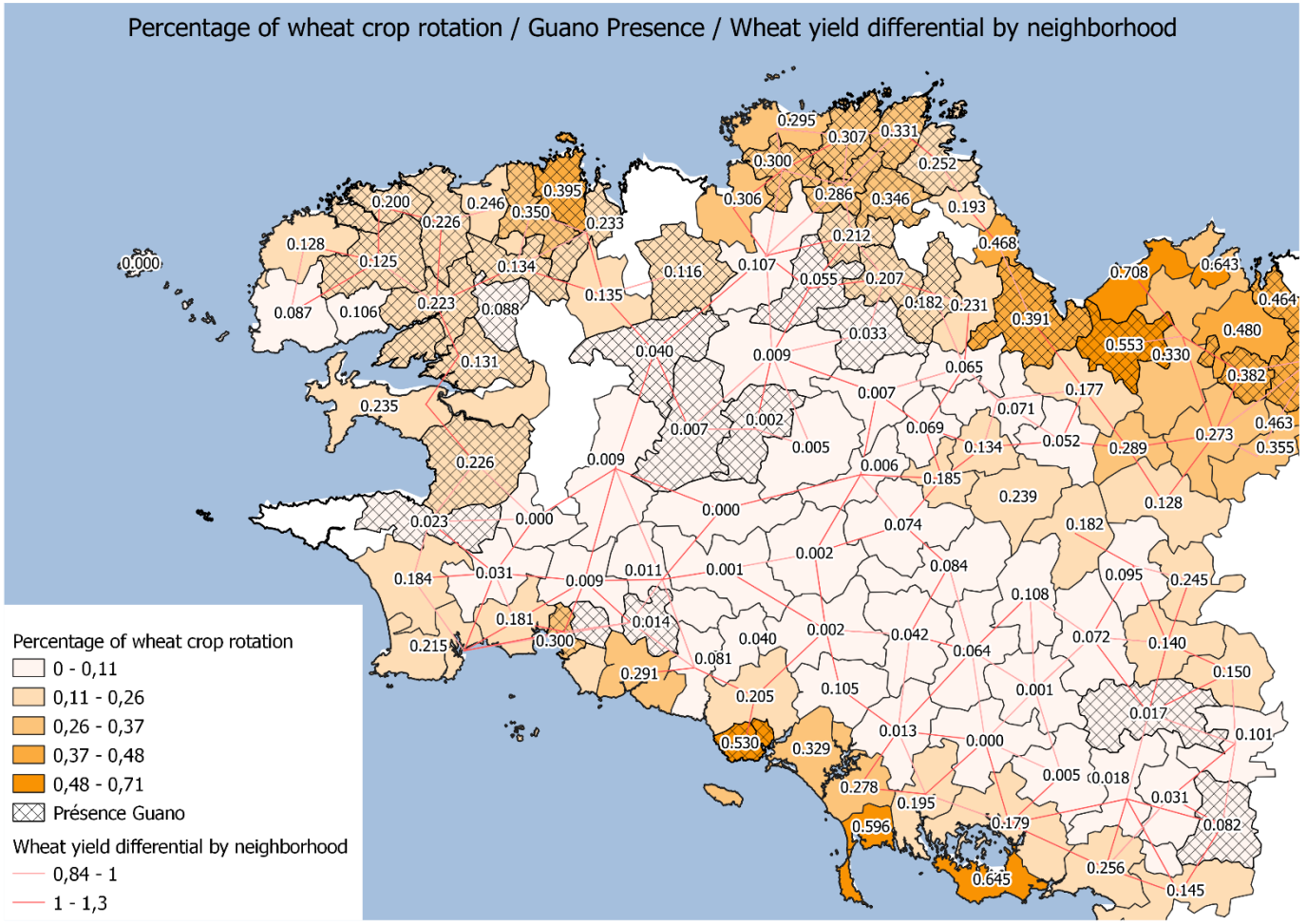


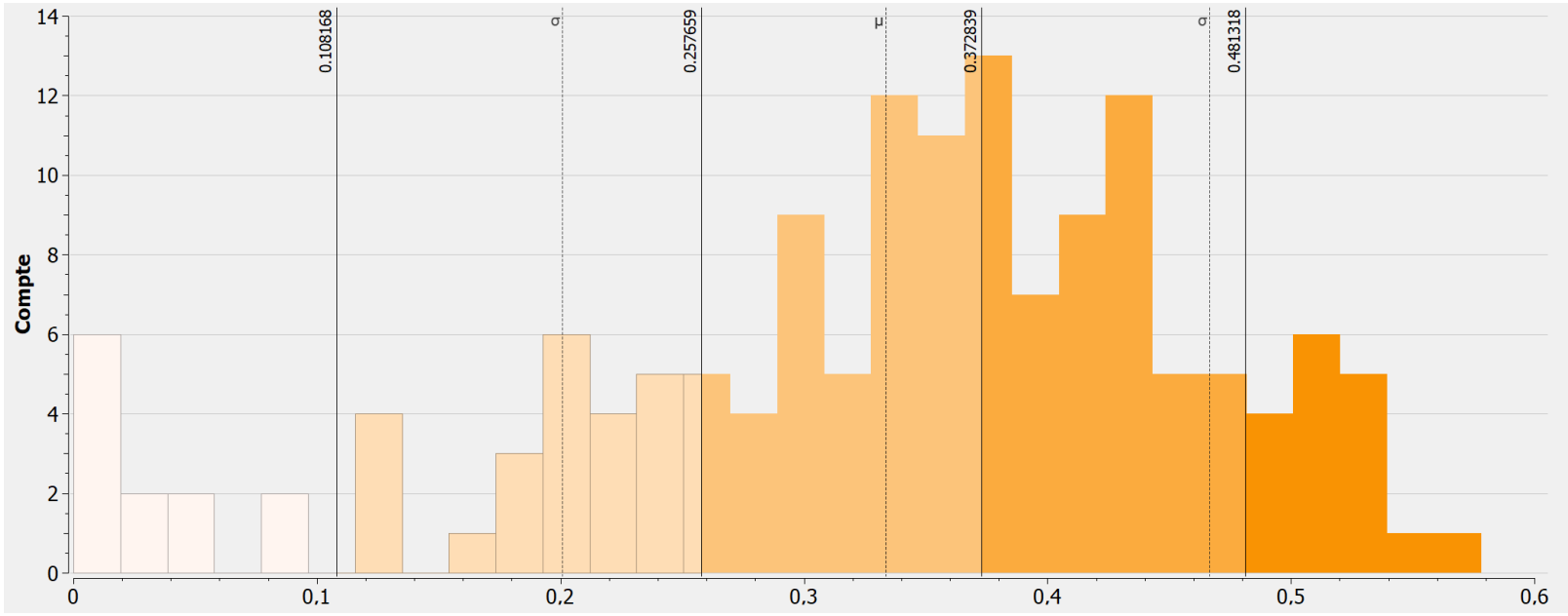
More discontinuity in cantons where noir animal is not used (15% of discontinuity in mean)

We try to use the same method to explore the spatial links between the use of guano (nitrogenous fertilizer) and other crops (potatoes and wheat) in the same region.
See map below wheat/guano. We used here the yields of wheat.

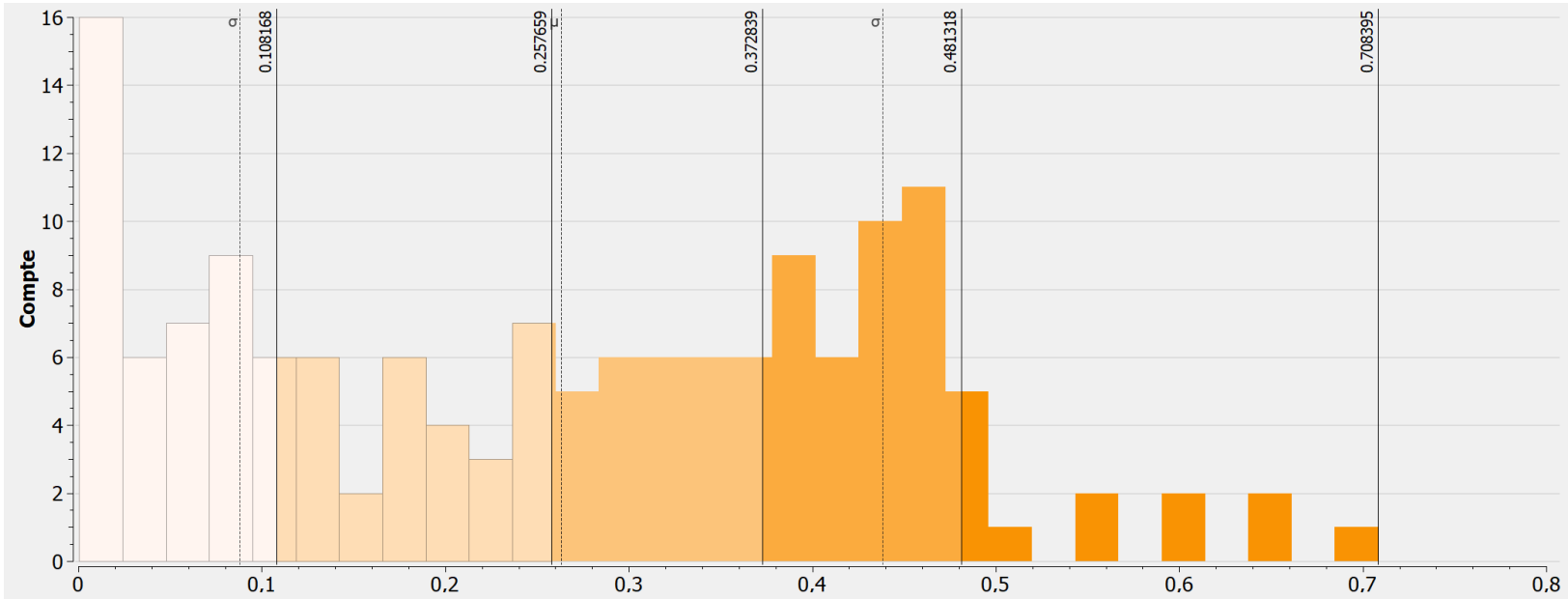


In this map we use the share of wheat in crop rotation and the use of guano. In any case link between crop and fertilizer is less clear than in the case of the relation buckwheat/noir animal.





Distribution des pct blé /présence de guano



Distribution des pct blé /absence de guano

II The complexity of the agrarian system and reliability of the sources.

- In the previous section we examine the spatial distribution between the kind of fertiliser mentioned (guano or “noir animal”) and the role of different crop (share of wheat and share of buckwheat) in the agrarian system.
- But the map and the analyse of continuity prove that it is difficult to understand the links between wheat (a cash crop) and buckwheat (subsistence crop) and the uses of fetilisers, i. e. guano –nitrogen fertiliser – and noir animal – phosphate fertilizer.
- In some areas there were wheat and buckwheat and use of the two fertilizers.

- We can notice that it is difficult to work with the yields. There are two reasons:
- - first it is very difficult to know how yields mentioned in the survey are assessed.
- - second (this is linked with the first remark) it is possible to wonder if in some canton this was not the best yields which are mentioned or if only a very tiny part of the lands was devoted to wheat (or buckwheat).
- We used logistic and regression models to try to assess the complexity of agrarian system.
- To better assess the relation between the use of noir and the performance of agrarian breton system we used logit regression. We want to know if there is a link between the use of « noir », and % of land devoted to buckwheat and yields of buckwheat, but also take into account the share of wheat and the yield of wheat.
- We also examine the link with the yields.

Class 1 reference: share of buckwheat < 10 %
Class 2 : > 10 % and < 25 %
Class 3 : > 25 % and < 33,33 %
Class 4: > 33,33 %
It is clear that the use of noir increased when the share of buckwheat increased.

```
. logistic noir i.classesarrasinpct

Logistic regression                             Number of obs     =        115
                                                LR chi2(3)        =      33.72
                                                Prob > chi2       =     0.0000
Log likelihood = -48.082594                     Pseudo R2         =     0.2596
```

noir	Odds Ratio	Std. Err.	z	P>|z|	[95% Conf.	Interval]
classesarrasinpct						
2	5.571429	3.286601	2.91	0.004	1.753236	17.70487
3	77.14285	85.80912	3.91	0.000	8.71906	682.5299
4	12.14286	9.418981	3.22	0.001	2.654974	55.53689
_cons	.4666667	.2136109	-1.67	0.096	.1902741	1.144548

The share with the yields was far less clear as prove the following regression.

```
. logistic noir i.classesarrasinpct i.classesarrasinr

Logistic regression                             Number of obs     =        110
                                                LR chi2(5)        =      35.02
                                                Prob > chi2       =     0.0000
Log likelihood = -42.642398                     Pseudo R2         =     0.2911
```

noir	Odds Ratio	Std. Err.	z	P>|z|	[95% Conf.	Interval]
classesarrasinpct						
2	5.553277	3.654706	2.60	0.009	1.52883	20.17156
3	87.6092	102.3065	3.83	0.000	8.88281	864.0703
4	11.94373	10.24715	2.89	0.004	2.222542	64.18447
classesarrasinr						
2	.6754885	.4674658	-0.57	0.571	.1740009	2.622312
3	3.060094	2.007791	1.70	0.088	.8457537	11.07199
_cons	.3315316	.2146492	-1.71	0.088	.0932002	1.179324

Class blé (yiel). Référence Yields < 12 hl/h; class 2: >12hl/h < 16 hl/h <; class 3 >= 16 hl/h et < 20 hl/h ; class 4 >= 20 hl/h
Classe blé (pct) Reference < 10 % ; class 2 >= 10 < 25 %; class 3 >33,33 %
It seems that the use of guano was link with an increase of the yields of wheat.

```
. logistic guano i.classeblepct i.classebler

Logistic regression                             Number of obs     =        110
                                                LR chi2(6)        =      30.68
                                                Prob > chi2       =     0.0000
Log likelihood = -54.906951                     Pseudo R2         =     0.2184
```

guano	Odds Ratio	Std. Err.	z	P>|z|	[95% Conf.	Interval]
classeblepct						
2	.7840651	.5236041	-0.36	0.716	.211794	2.902622
3	1.354765	.8899036	0.46	0.644	.3738829	4.908991
4	4.96023	3.402975	2.33	0.020	1.292806	19.03138
classebler						
2	3.245156	2.705068	1.41	0.158	.6334301	16.62542
3	7.876561	6.536282	2.49	0.013	1.548731	40.05874
4	44.75829	44.66551	3.81	0.000	6.330478	316.454
_cons	.0613009	.0515528	-3.32	0.001	.011793	.3186469

The following linear regression seems indicate that the share of wheat (blepct) has no effect on the yields, but that high yields of buckwheat were associated with high yelds of wheat. The more the yields of buckwheat is high the more the yields of wheat was high.

```
. regress bler blepct sarrasinpct sarrasinr
```

Source	SS	df	MS		
Model	225.05212	3	75.0173735	Number of obs	= 106
Residual	1363.77385	102	13.3703319	F(3, 102)	= 5.61
				Prob > F	= 0.0013
Total	1588.82597	105	15.1316759	R-squared	= 0.1416
				Adj R-squared	= 0.1164
				Root MSE	= 3.6565

bler	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
blepct	-1.215952	2.466057	-0.49	0.623	-6.107364	3.675459
sarrasinpct	-8.283976	3.432908	-2.41	0.018	-15.09313	-1.474819
sarrasinr	.2972333	.0828407	3.59	0.001	.1329193	.4615474
_cons	12.05324	1.929936	6.25	0.000	8.225218	15.88126

Thus there was not a simple link between yields of wheat and share of wheat in crop rotation, but there is a link between the use of guano and the yields of buckwheat…

```
. regress bler blepct sarrasinpct sarrasinr i.guano
```

Source	SS	df	MS		
Model	401.488362	4	100.372091	Number of obs	= 106
Residual	1187.33761	101	11.7558179	F(4, 101)	= 8.54
				Prob > F	= 0.0000
Total	1588.82597	105	15.1316759	R-squared	= 0.2527
				Adj R-squared	= 0.2231
				Root MSE	= 3.4287

bler	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
blepct	-2.160888	2.325204	-0.93	0.355	-6.773467	2.451692
sarrasinpct	-5.592067	3.293117	-1.70	0.093	-12.12472	.9405902
sarrasinr	.2473583	.0787378	3.14	0.002	.0911637	.4035528
1.guano	2.843671	.7340268	3.87	0.000	1.38756	4.299783
_cons	11.63103	1.812944	6.42	0.000	8.034643	15.22743

Conclusion

- The survey of 1862 remains a major source (unexploited by historians until recently) to study the introduction of fertilizers in France at a very early date. Dispite the qualitative character of data, it is possible to analyse specific utility of fertilizers. Here the association with GIS allows not only to produce maps but also to examine with detail the specific pattern of use of specific fertilizers.
- The survey allows also to better assess the global logic of the uses of fertilizers taking in account the infra-regional diversity and the crop rotation.
- From a historical point of view, this study show that despite the very bad renown of the Brittany, farmer in this area was capable to use fertilizers in an efficient way, not only for commercial crops but also to improve the subsistence crop.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Obrigado
Gracias
Thank you.
Merci.