



**HAL**  
open science

# Modeling the spatial distribution of cropping systems at a large regional scale: a case of crop sequence patterns in France between 1992 and 2003

Ying Xiao, Catherine C. Mignolet, Jean François Mari, Marc Benoît

► **To cite this version:**

Ying Xiao, Catherine C. Mignolet, Jean François Mari, Marc Benoît. Modeling the spatial distribution of cropping systems at a large regional scale: a case of crop sequence patterns in France between 1992 and 2003. ESA 2012, European Society for Agronomy (ESA). INT., 2012, Helsinki, Finland. 598 p. hal-02746360

**HAL Id: hal-02746360**

**<https://hal.inrae.fr/hal-02746360>**

Submitted on 3 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.

# Modeling the spatial distribution of cropping systems at large regional scale: a case of crop sequence patterns in France during 1992-2003

## Introduction

Over the past decade, the scientific interest of the location of cropping systems, including both the crop sequences and the crop management systems, has been increasingly noticed by researchers who associated crop rotations instead of single crop for representing cropping patterns in their models (nitrogen fluxes, animal habitat preference, etc.) and further analyzing the environmental impacts of agricultural production systems. However, in existing modeling frameworks of land-use/cover change, especially agricultural land-use change, few models integrate agricultural land management practices such as crop rotations (Schonhart et al., 2011). In this paper, we aim at investigating crop sequence patterns at large regional scale by performing statistic technique on surveyed land-cover data.

## Materials and Methods

The land-cover data was derived from an annual French national land-cover census data, Teruti, from 1992 to 2003. The land unit studied was the French agricultural district and all of the 430 agricultural districts were incorporated in this research. By combining the application of CARROTAGE (Le Ber et al., 2006), a second-order Hidden Markov Model based on stochastic theory and a classic statistic technique, Principal Component methods prior to Agglomerative Hierarchical Methods (AHC) using software R package FactoMineR (Husson et al., 2010), we developed a modeling approach to identify the spatial distribution of crop sequences at the French metropolitan scale. We considered 3-year crop sequences as distinct land-use types. Firstly, we applied CARROTAGE for discovering the temporal regularities of land-use within each district. The probabilities of occurrences of 3-years land-use successions previously calculated were used as independent variables to build a table for classifying districts. Secondly, we performed the Principal Component Analysis (PCA) on this table in which 510 principal crop sequences were used as active variables. In order to facilitate the interpretation of clusters, we introduced 6 permanent non-agricultural land-use successions which contained forest, water, artificial area and stone area as supplementary variables. Finally, we performed a hierarchical clustering on the principal components using the function 'HCPC' integrated in FactoMineR with predefining the number of clusters between 20 and 30. We then mapped this classification with ArcGIS.

## Results

The first 119 components of the PCA explained 80.2% of the total inertia and thus were used for clustering. With the optimal level of division suggested by the HCPC function, a classification of districts into 20 clusters was produced. We observe the differentiation of crop sequences among regions (Fig 1). We also detect the livestock farming systems zone with crop sequences predominantly involving maize and temporary pasture, the cereal and vegetable farming systems zone including wheat, barley, sugar beet and pea based crop sequences, etc. Details of the clusters' description are shown in Table 1.

## Conclusion

We emphasize that the crop sequence patterns identified in this study seem plausible in comparison to the result of the farming Systems survey OTEX which was published by the French Ministry of Agriculture in 2000. Our modeling approach can be considered as a generic approach tested at French metropolitan scale, and it provides a useful tool for agronomists to represent past agricultural land-use patterns at the global scale.

## References

- Le Ber, F., Benoit, M., Schott, C., Mari, J.F., Mignolet, C., 2006. Studying crop sequences with CARROTAGE, a HMM-based data mining software. *Ecological Modelling* 191, 170-185.
- Husson, F., Lê, S., Pagès, J., 2010. *Exploratory Multivariate Analysis by Example Using R*, Computer Science and Data analysis Series. Chapman & Hall/CRC, p. 228.
- Schonhart, M., Schmid, E., Schneider, U.A., 2011. Crop Rota - A crop rotation model to support integrated land use assessments. *European Journal of Agronomy* 34, 263-277.

Comment citer ce document :

Xiao, Y. (Auteur de correspondance), Mignolet, C., Mari, J. F., Benoit, M. (2012). Modeling the spatial distribution of cropping systems at a large regional scale : a case of crop sequence patterns in France between 1992 and 2003. In: 12. Congress of the European Society of Agronomy (p. 174-175). Department of Agricultural Sciences publications. 14. Presented at ESA

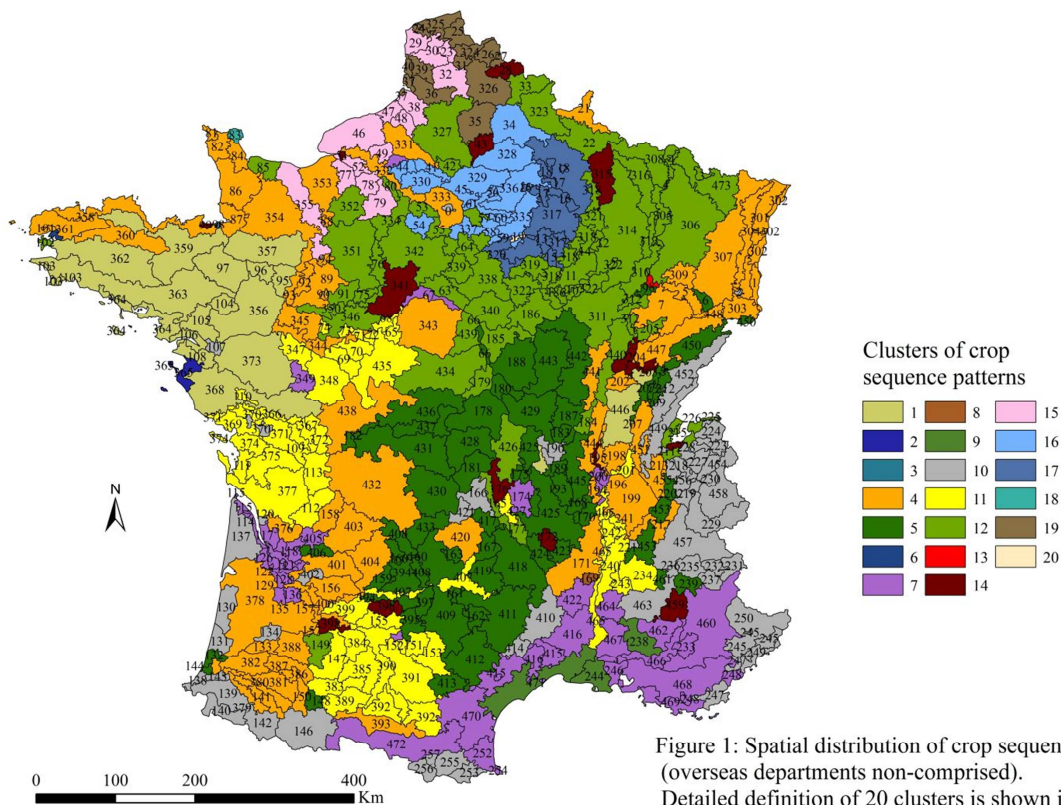


Figure 1: Spatial distribution of crop sequences in France (overseas departments non-comprised). Detailed definition of 20 clusters is shown in Table 1.

Table1: Description of the Partition into 20 clusters from the initial variables. Supplementary variables are in *Italic*. Nomenclature used is: A (apple tree), B (barley), Bn (broad bean), F (forest), Fa (fallow), G (grassland), Gv (vegetables garden), H (herb area), M (Maize), N (nursery), O (oat), Oc (other cereals), OS (other surface), Ol (oil crops), Ov (other vegetables), P (pea), Pa (artificial pasture dominant in alfalfa), Pm (mountain pasture), Ps (potato), Pt (temporary pasture), R (rapeseed), S (sunflower), Sb (sugar beet), St (stone area), Tx (textile crops), V (vineyards), W (wheat).

Cluster	Crop sequences
1	M-Oc-Pt, Pt-M-Oc, Pt-M-Pt, Pt-M-P, W-Pt-M, M-W-Pt, M-Pt-M, Pt-Pt-M, W-M-Oc, Oc-M-Oc
2	OS-OS-S, Ov-Ov-Ov, V-Ov-Ov, W-Pt-S, W-Oc-W, W-W-R, Ol-W-Ol, Pt-M-Pt, Pt-M-P, Ps-Ps-Ps
3	Pt-B-W, M-W-Ov, Pt-W-B, W-B-Ov, M-B-M, M-W-O, P-W-Ov, P-W-Pt, Pt-Fa-Fa, Fa-P-W
4	M-M-Pt, M-M-M, Pt-M-M, M-Pt-Pt, G-M-M, Fa-M-M, M-M-P, M-W-M, R-W-M, M-M-W
5	O-Pt-Pt, Oc-Oc-Pt, Oc-Oc-P, Pt-Pt-B, Pt-Pt-Pt, G-W-B, Pt-Pt-G, B-B-Pt, Oc-Pt-Pt, G-G-Oc
6	Ps-Gv-Gv, W-Oc-R, OS-Gv-Gv, S-Gv-Gv, Oc-R-W, R-W-Oc, W-B-Ps, R-W-O, OS-Fa-Fa, Pt-Pt-Fa
7	V-V-V, Fa-OS-OS, V-V-F, V-V-Fa, OS-OS-Fa, A-OS-OS, OS-Fa-Fa, Fa-Fa-OS, G-G-OS, G-OS-OS
8	W-Sb-M, S-M-W, B-M-S, W-Sb-S, M-S-M, Gv-Gv-OS, W-Fa-R, S-W-Ol, H-H-H, OS-OS-Fa
9	Oc-Oc-Oc, Oc-Oc-O, Oc-Oc-W, Ov-M-W, V-M-W, W-W-Ov, Pa-Pa-Pa, H-OS-OS, Ov-W-W, V-W-W
10	<i>St-St-St</i> , <i>Pm-Pm-Pm</i> , <i>OS-OS-OS</i> , OS-OS-O, H-H-H, Ov-M-M, V-M-M, B-B-Fa, B-B-F, Fa-Fa-Pt
11	S-W-S, W-S-Fa, W-S-B, Fa-Fa-S, R-W-S, Fa-W-S, S-Fa-Fa, W-S-W, W-S-S, S-S-W
12	W-W-B, B-R-W, Fa-W-R, W-B-R, W-Fa-W, R-W-B, W-R-B, P-W-B, B-Fa-W, Fa-W-B
13	G-S-W, M-W-R, B-Pt-Pt, Pt-G-G, Fa-W-M, Pt-Pt-G, B-Fa-W, Fa-R-W, W-B-Fa, W-B-F
14	W-M-Ov, Sb-W-O, S-M-S, B-W-Ov, Sb-W-Ov, Ol-Ol-W, P-W-Fa, B-M-O, Fa-W-Fa, W-M-O
15	P-W-Tx, B-W-Tx, Sb-W-Tx, B-Tx-W, W-B-Tx, Tx-W-W, Tx-W-B, Tx-W-Tx, B-Pt-W, W-Pt-W
16	N-W-Sb, Bn-W-Sb, P-W-Sb, W-Pa-W, Bn-W-S, Sb-W-Sb, B-W-Sb, P-W-S, W-Sb-W, B-Bn-W
17	B-Pa-Pa, Pa-Pa-W, W-Sb-B, Pa-W-S, W-B-Pa, Sb-B-B, Sb-B-R, Sb-B-P, B-B-Sb, Pa-W-B
18	Ps-Sb-W, Ps-W-Ps, S-W-Ps, S-Sb-W, Ps-W-P, Ps-W-M, Ov-W-Ov, Ov-W-O, S-W-P, W-Ov-Ov
19	Ps-W-Ov, P-W-Ps, Sb-W-Ps, B-W-Ps, S-W-Ov, W-Ov-W, Ps-W-B, M-W-Sb, W-Ov-P, W-Ps-W
20	R-W-Ov, B-Ov-W, P-W-Ov, Ov-W-B, V-W-B, Ov-W-Ps, Ov-W-P, Ps-W-Sb, Ov-W-Sb, W-W-M

Comment citer ce document :

Xiao, Y. (Auteur de correspondance), Mignolet, C., Mari, J. F., Benoit, M. (2012). Modeling the spatial distribution of cropping systems at a large regional scale : a case of crop sequence patterns in France between 1992 and 2003. In: 12. Congress of the European Society of Agronomy (p. 174-175). Department of Agricultural Sciences publications. 14. Presented at ESA