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An integrative multi-scale approach to regional agriculture to support the assessment and benefit of pest-regulation services delivered by biodiversity

Annick Gibon*, Audrey Alignier*, Gérard Balent*, Vincent Bretagnolle**, Nadège Garambois***, Claire Lavigne*, Sandrine Petit*, Claudine Thenail*, Jean-François Toubon*, Sophie Devienne***

*INRA, **CNRS, ***AgroParisTech

INRA SCIENCE & IMPACT

AgroParisTech INSTITUT DES SCIENCES ET INDUSTRIES DU VIVANT ET DE L'ENVIRONNEMENT PARIS INSTITUTE OF TECHNOLOGY FOR LIFE, FOOD AND ENVIRONMENTAL SCIENCES

cnrs dépasser les frontières

Research study context

SEBIOPAG

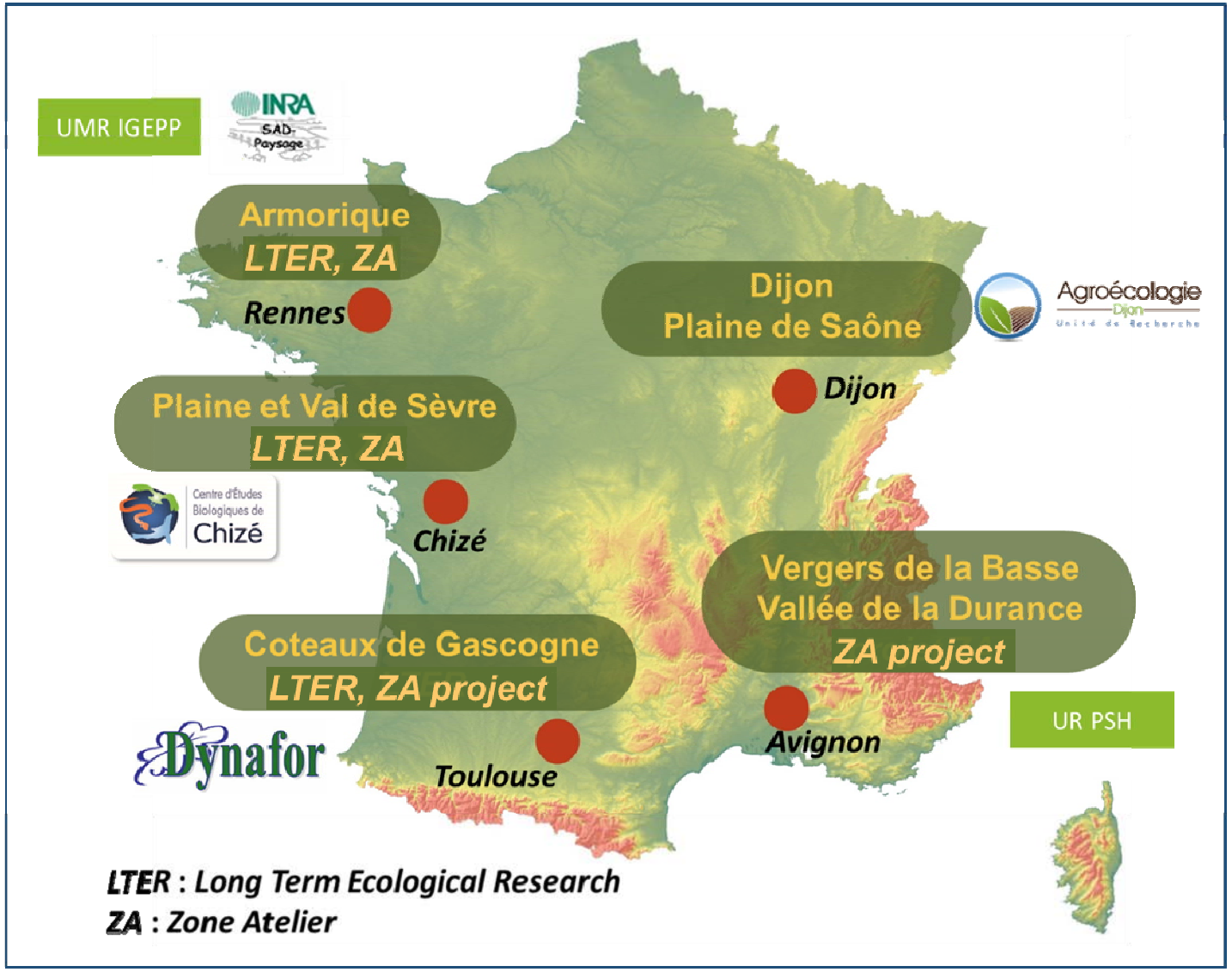
An INRA-CNRS long-term research network on ES, biodiversity & landscape interactions

www.sebiopag.inra.fr/

SEBIOPAG-Phyto

(2014-2017): An ongoing research on the effects of phytos on biodiversity & ES

100-parcel network over the 5 regions



Research questions

SEBIOPAG-Phyto

♘ pesticide use to benefit pest-regulation ecosystem services (ESs)

- Effect of reduced pesticide application on pest-regulation and crop yield
- Effect of cropping system and landscape context on pest regulation
- Operational knowledge for supporting farmers' consideration of pest-regulation ESs in their cropping system management

Research assumptions and design

SEBIOPAG-Phyto

Tscharntke et al. 2012; Baudry et al. 2003; Petit et al. 2013

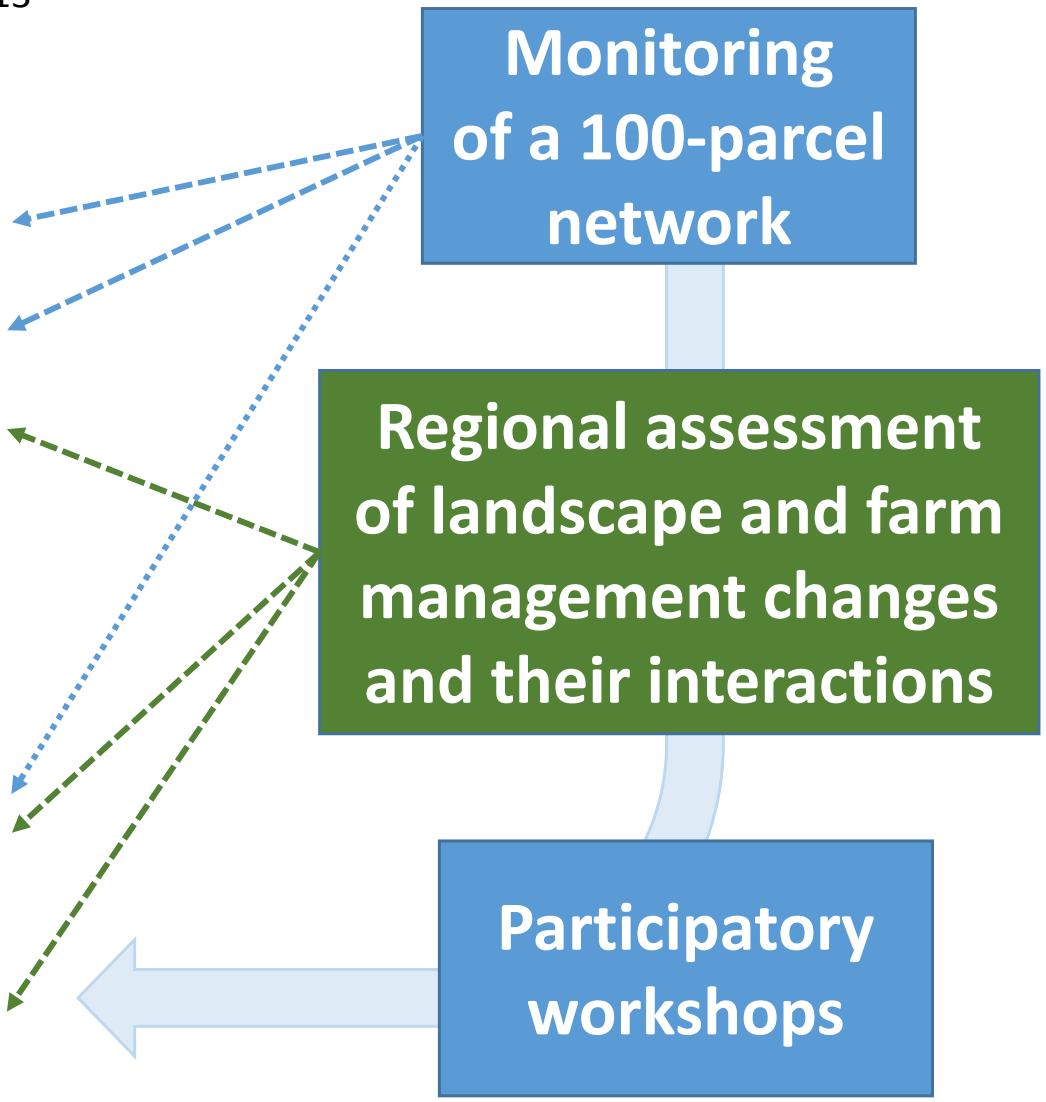
Pest-regulation ESs depend on

- cropping system
  intensity of pesticide use
- landscape context
  - parcel-surrounding landscape
  - regional current/past landscape

Support to adoption of new crop-management practice

- farm level
  adaptive management behaviour of farmer (short & long-term strategy)
- regional level
  diversity of farming systems operation and dynamics

Darnhoffer et al 2011; Pacini et al 2014



Integrated assessment of interactions between landscape, ESs & land management

- **a wide-spreading view of methodological requirements**
  - a social-ecological conceptual framework
  - a multiscale and spatially-explicit approach
  - an explicit address of long term dynamics

  Wu & David 2002
  Liu et al. 2007
  Pelosi et al. 2010
  Burgi et al. 2015
  Lescourret et al. 2015

- **a lack of methods for regional application**
  - few comprehensive regional studies in literature
  - heavy and time-consuming implementation designs [e.g. Gibon et al. 2015]

⇨ **choice of a proven generic method with a distinct purpose**

- **'Agrarian System Diagnosis' (ASD)** [Cochet & Devienne 2006]

  UFR Agriculture comparée et Développement agricole, AgroParisTech

  – techno-economic assessment of change in regional agricultures
  – aim: supporting regional choice of agricultural development orientations
  – usual implementation: MSc research projects monitored by a professor

ASD conceptual framework

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UFR Agric. comparée & Dév. agricole

- **a production system**: a set of production units (farms) with
  - similar resources
    - agricultural land condition, surface area, equipment, workforce
  - comparable socioeconomic conditions of operation
  - a same combination of crop and livestock productions
- **Regional agriculture:** a set of production systems (farm types)
  - resulting from an **historical process of farm differentiation**
  - driven by: technological change, agricultural economics and public policies, and resource availability at the farms

[Cochet & Devienne, 2006; Moreau et al. 2012]

Method for ASD application in a region

- Generic design: field-assessment & systemic modelling

Components	Results	Data collection
Landscape analysis	*Delineation and characterisation of landscape units within the region*	field observations + geological and topographical maps
Assessment of historical change in prod. systems	*- regional types of production systems at a reference date (1940-50)* *- respective trajectories of change, their main drivers and processes*	interviews of retired farmers, advisors,… + regional literature
Assessment of current types of prod. systems	*Techno-economical operation* *Economic performance* *Prospects for change*	interviews of active farmers

[source: Cochet & Devienne 2006; Moreau et al. 2012]

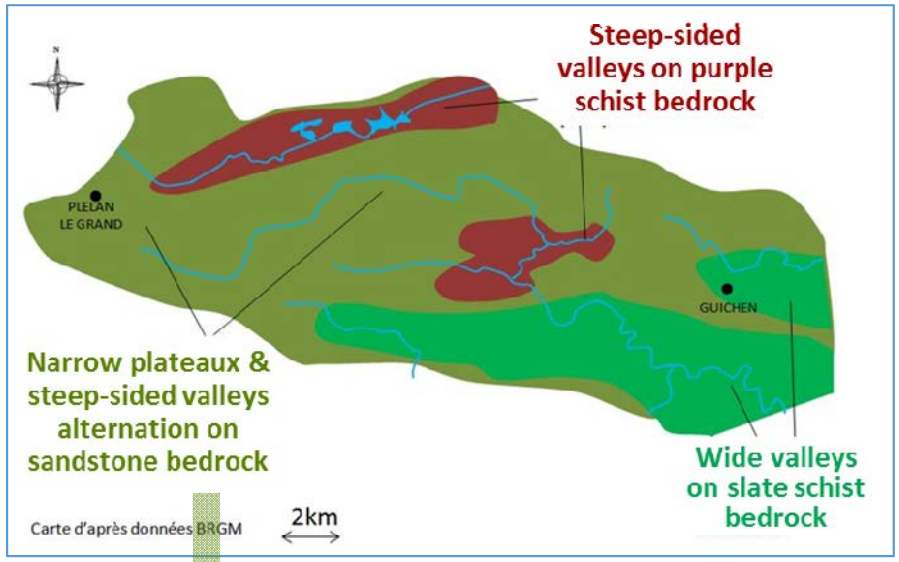
- SEBIOPAG-Phyto : emphasis on significant indicators / biodiversity:
  hedges and forests, grasslands & grazing lands, pounds; parcel size ….

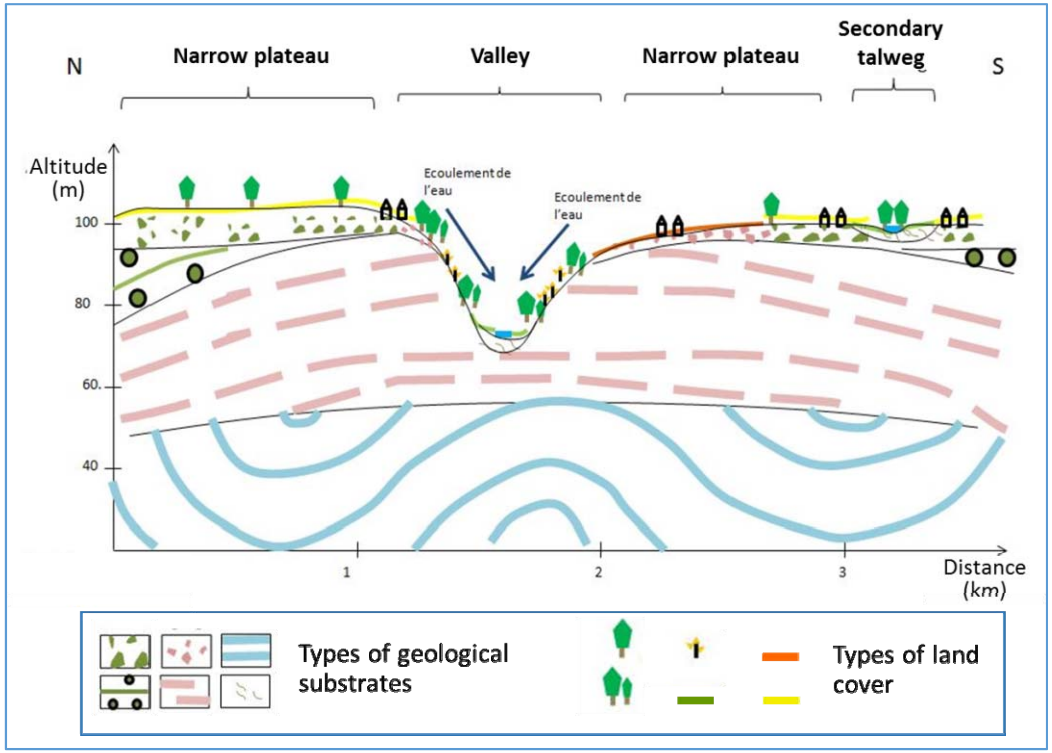
Results – Ecological landscape

- agroecological areas and inner landscape organisation

  Ex: agroecological areas (left) *and a landscape unit* (right) *in the Brittany study region*

  [Valory 2015]





- main temporal phases, processes and drivers of past change in ecosystem-mosaic composition and configuration
  - semi-natural elements, agroecosystem types and sizes within landscape units

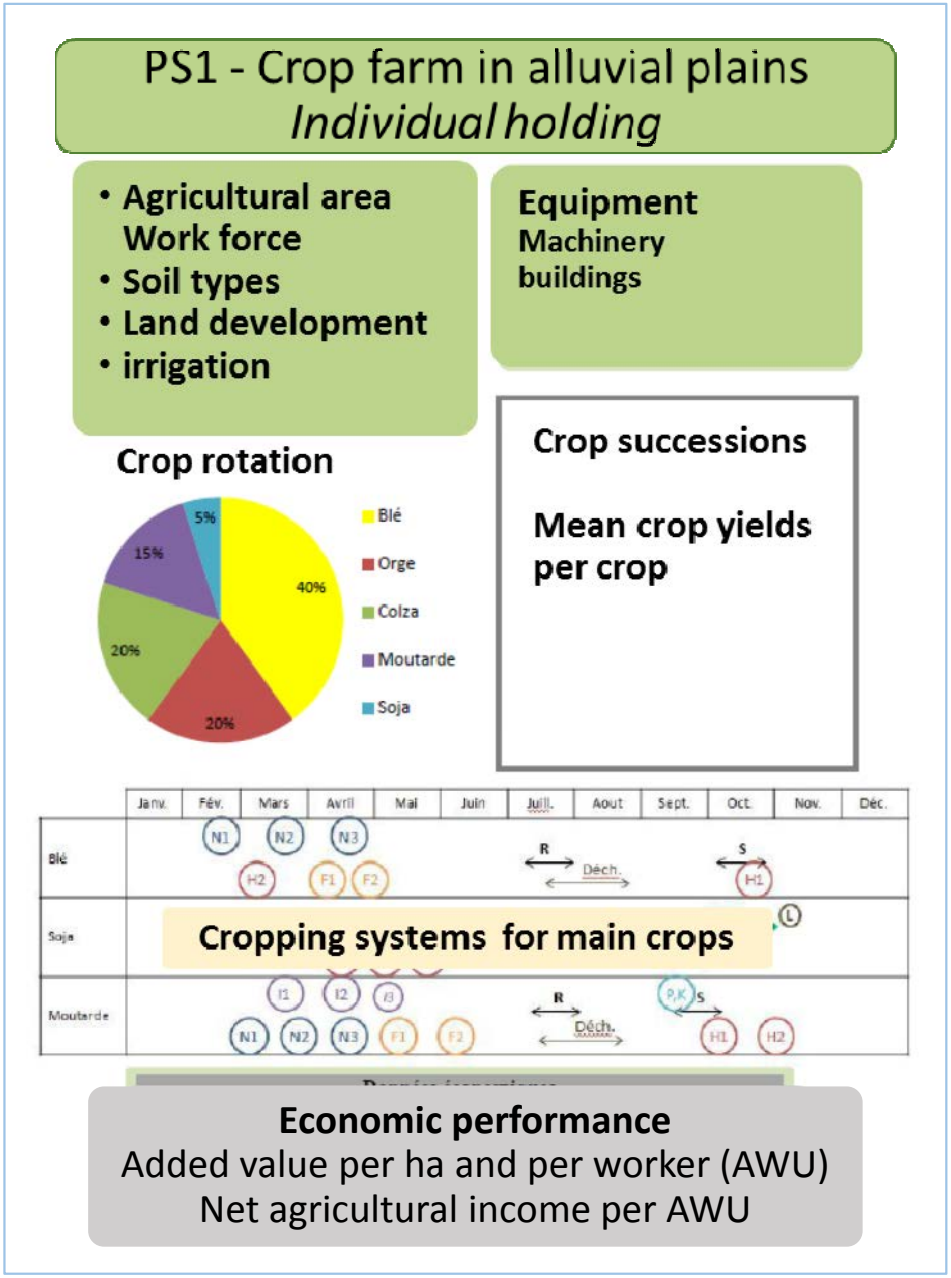
Results- Farming systems and their dynamics

- Types of production systems within each region (*12 to 16*)
  - farm structure
  - techno-economic operation
  - cropping systems
  - economic performance

Ex.: synopsis PS1 - Dijon plain

[Villefranche 2015]

- Trajectories of change (⇦ 1940s)
  - successive phases in their evolution
  - drivers of change (region/farm level)
  - types of farmer adaptive decisions over time and techno-economical rationales
  - farmland and landscape changes and their technological & economic drivers



Results- **operational knowledge** (*under progress)*

Farm level

Support to adoption of ESs-based practices of pest control

Integration of parcel-monitoring and ADS results to assess desirable & applicable changes according to farm type & farmer strategy

- Effect of crop management practice on pest regulation
  - *assessment of farms owning monitored parcels for locating them within production-system typology*
  - *correspondence between monitored crop management systems and those identified in ADS according to farm types*
- Levers & barriers to innovation adoption according to farm type
  - *whole-farm biotechnical operation and management*
  - *farm socio-economics and LT farm development strategy*

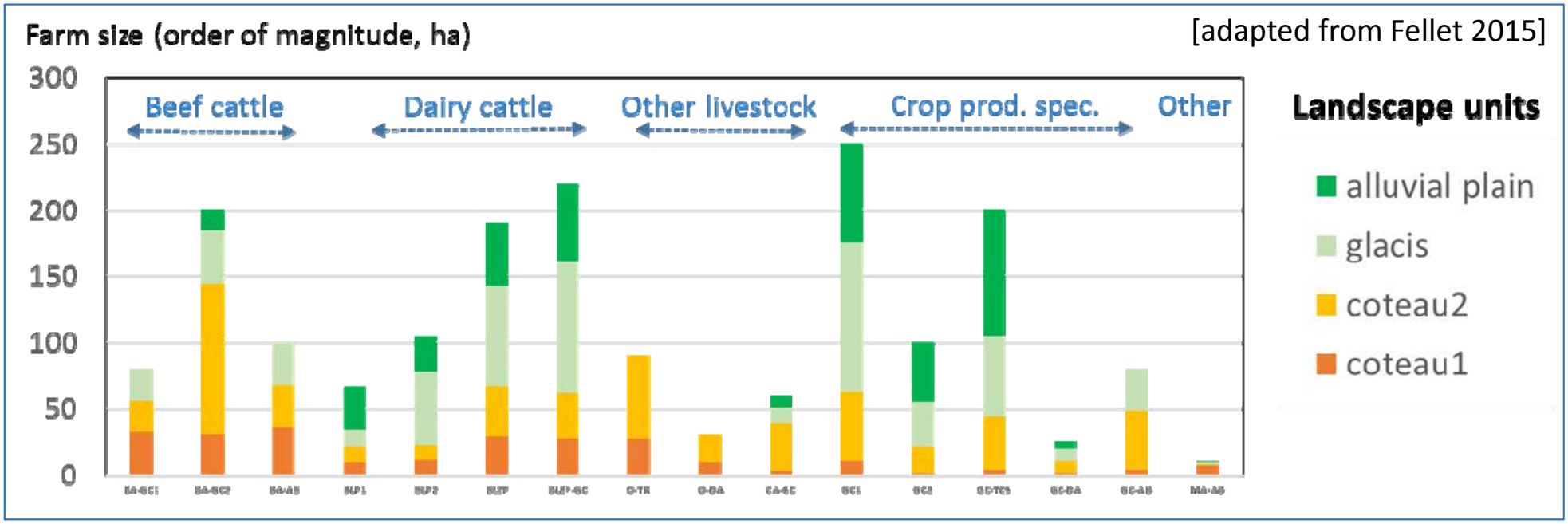
Results- **operational knowledge** (*under progress)*

Region level

Place-specific challenges and ways for action towards more sustainable pest-control management

- Landscape and its change; level and and trends for change in pesticide use /farm types; individual farm contribution to and dependence on landscape units, …

Ex. farm territory composition according to farm types -coteaux de Gascogne



Conclusion and outlook

ASD : a valuable contribution to ESs-focused research

- progress in interdisciplinary research group / common understanding of nested interrelationships between natural and agricultural systems at the region level
- operational tool to overpass methodological stumbling blocks in multiscale assessment of interactions between ecological processes and management practice

- avenues to be pursued
  - frameworks and indicators to facilitate integration of results of set of approaches applied within region
  - ASD application in projects on landscape functions and ESs in landscape ecology for enhancing knowledge /functional relationships between landscape and agricultural activities

Thank you for your attention

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References quoted

Baudry, J., Burel, F., Aviron, S., Martin, M., Ouin, A., Pain, G., & Thenail, C. 2003. Temporal variability of connectivity in agricultural landscapes: do farming activities help? ***Landscape Ecology***, 18: 303-314.

Bianchi, F. J. J. A., Mikos, V., Brussaard, L., Delbaere, B., & Pulleman, M. M. 2013. Opportunities and limitations for functional agrobiodiversity in the European context. ***Environmental Science & Policy***, 27: 223-231.

Burgi, M., Silbernagel, J., Wu, J. G., & Kienast, F. 2015. Linking ecosystem services with landscape history. ***Landscape Ecology***, 30: 11-20.

Cochet, H. & Devienne, S. 2006. Fonctionnement et performances économiques des systèmes de production agricole: une démarche à l'échelle régionale. ***Cahiers Agricultures***, 15: 578-583.

Fellet, P. 2015. *Analyse-diagnostic agraire de la petite région agricole des coteaux de Gascogne* .

Lescourret, F., Magda, D., Richard, G., Adam-Blondon, A. F., Bardy, M., Baudry, J., Doussan, I., Dumont, B., Lefevre, F., Litrico, I., Martin-Clouaire, R., Montuelle, B., Pellerin, S., Plantegenest, M., Tancoigne, E., Thomas, A., Guyomard, H., & Soussana, J. F. 2015. A social-ecological approach to managing multiple agro-ecosystem services. ***Current Opinion in Environmental Sustainability***, 14: 68-75.

Liu, J. G., Dietz, T., Carpenter, S. R., Folke, C., Alberti, M., Redman, C. L., Schneider, S. H., Ostrom, E., Pell, A. N., Lubchenco, J., Taylor, W. W., Ouyang, Z. Y., Deadman, P., Kratz, T., & Provencher, W. 2007. Coupled human and natural systems. ***Ambio***, 36(8): 639-649.

Moreau, P., Ruiz, L., Mabon, F., Raimbault, T., Durand, P., Delaby, L., Devienne, S., & Vertes, F. 2012. Reconciling technical, economic and environmental efficiency of farming systems in vulnerable areas. ***Agriculture, Ecosystems and Environment***, 147: 89-99.

Pelosi, C., Goulard, M., & Balent, G. 2010. The spatial scale mismatch between ecological processes and agricultural management: Do difficulties come from underlying theoretical frameworks? ***Agriculture, Ecosystems and Environment***, 139: 455-462.

Petit, S., Alignier, A., Colbach, N., Joannon, A., Le Coeur, D., & Thenail, C. 2013. Weed dispersal by farming at various spatial scales. A review. ***Agronomy for Sustainable Development***, 33: 205-217.

Tscharntke, T., Tylianakis, J. M., Rand, T. A., Didham, R. K., Fahrig, L., Batary, P., Bengtsson, J., Clough, Y., Crist, T. O., Dormann, C. F., Ewers, R. M., Frund, J., Holt, R. D., Holzschuh, A., Klein, A. M., Kleijn, D., Kremen, C., Landis, D. A., Laurance, W., Lindenmayer, D., Scherber, C., Sodhi, N., Steffan-Dewenter, I., Thies, C., van der Putten, W. H., & Westphal, C. 2012. Landscape moderation of biodiversity patterns and processes - eight hypotheses. ***Biological Reviews***, 87: 661-685.

Valory, A. 2015. *Diagnostic agraire dans la petite région des collines de Guchen*.

Villefranche, A. 2016. *Diagnostic agraire du Sud de la Plaine de Dijon, Côte d'Or*.

Wu, J. & Hobbs, R. 2002. Key issues and research priorities in landscape ecology: An idiosyncratic synthesis. ***Landscape Ecology***, 17: 355-365.