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Enhancing Innovation in Cross-disciplinary Research: lessons from an Innovative Design approach

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1. Introduction and research question

- Design and research : separated activities ?
  But design can occur within research, for example, when designing innovative research projects *(Hatchuel, Reich, Le Masson, Weil & Kazakçi, 2013)*.

- Cross-disciplinary research : considered as a potential for innovation
  sharing knowledge from varied disciplines => innovative nature of projects *(Kostoff, 1999)*.

- In practice : a real challenge
  => may provide contrasted results *(Dewulf, François, Pahl-Wostl, Taillieu, 2007)*
  => gathering researchers from various disciplines is not enough to innovate

⇒ How to favor this interplay between disciplines ? What are the key factors of design in cross-disciplinary context ?
⇒ Which tools and methods to further cross-disciplinary design ?

Outlines

- **Literature review** on cross-disciplinary research
- **Methodology**
  - Case study : Network on animal antibiotics
  - Case analysis : C-K theory
- **Results**
  - Several C-K trees
  - Outputs of the workshops
  - Evaluation of the C-K exploration and of the projects
- **Conclusions**

2. Literature review

Cross-disciplinary research includes several forms of **disciplines/knowledge crossing** :

- **Multidisciplinarity**: juxtaposition of disciplines, each discipline works in a self-contained manner.
- **Interdisciplinarity**: practice of transfers from one discipline to others.
- **Transdisciplinarity**: the focus is on the organization of knowledge around complex heterogeneous domains rather than the discipline.

(Bruce, Lyall, Tait, Williams, 2004; Ramadier, 2004)

Interaction between researchers:

Multidisciplinarity

Interdisciplinarity

Transdisciplinarity

(Rosenfield, 1992)

2. Literature review

Many challenges for the design of cross-disciplinary research programs

- Science and technology become more and more specialized *(Kostoff, 1999)*
- The lack of acceptance of paradigm shift *(Karniouchina, Victorino & Verma, 2006)*
- Communication and coordination problems, misunderstandings, and mismatched expectations *(Dewulf, François, Pahl-Wostl, Taillieu, 2007)*

Methodology to analyze results from cross-disciplinary research ?

Successful transdisciplinary research centers:
If "they promote the development of novel conceptual models" *(Stokols, 2006)*

=> **No specific language to study knowledge or disciplines crossing, or even their impact**

This is why it is important to develop tools and methods to better **understand and control the interplay between knowledge in cross-disciplinary research**, and thus enhance the **design of cross-disciplinary research projects**

3. Methodology

CASE STUDY

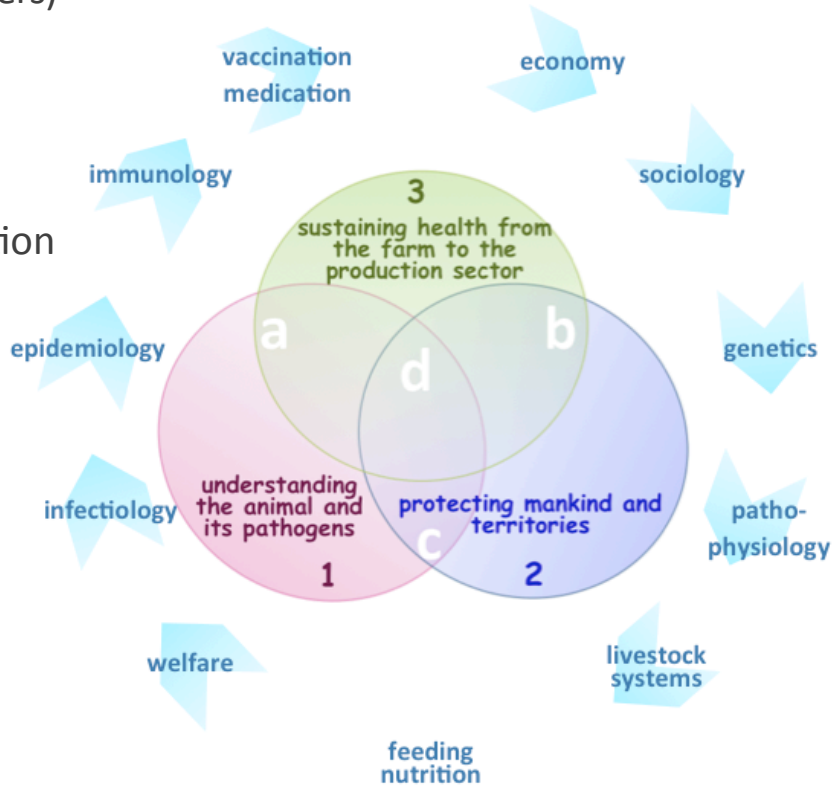
Agriculture, food and nutrition, environment
10,000 people (1,800 researchers, 2,400 engineers)
17 centers in France
13 disciplinary "departments"

Launched "**Metaprograms**" in 2011, which aim is:

- to promote cross-disciplinary research and innovation
- on major issues for the society
- with a close connection to stakeholders

→ 10 metaprograms were launched, among which
GISA = Sustainable Management of Animal Health

Gestion Intégrée de la Santé des Animaux



3. Methodology

CASE STUDY

Among GISA, the network **R2A2** was funded : **Research network on a reduced use of antibiotics and decreased resistance to antibiotics in animal production**

Context

High biological constrains
Increase of resistance to various antibiotics
No new antibiotics
Risk for Human health

Strong demand
Strong political demand for a reduction in the use of antibiotics : EcoAntibio 2017 plan, 25% decrease

Challenge for research
Interest in this topic in various disciplines, but lack of collaborations between disciplines

Aim

Cross-disciplinary dynamics and link between research and field work to identify scientific questions of interest for farm practice and innovative approaches to antibiotic use

3. Methodology

CASE STUDY

Research network on a reduced use of antibiotics and decreased resistance to antibiotics in animal production

Management
Christian Ducrot

Steering committee
- Define agenda

Meetings
- A scientific question
- A farming industry presented
- Small workshop on identified interesting question

Working group on innovation → meetings
MINESParisTech: J Brun, P Le Masson, B Weil

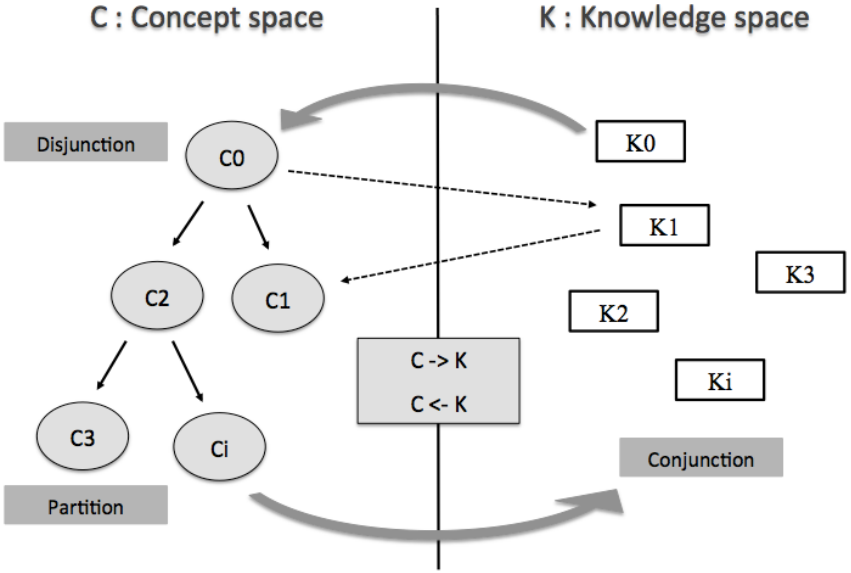
INRA: A Bousquet-Melou, C Belloc, Jean-F Cosson, C Ducrot, G Vourc'h

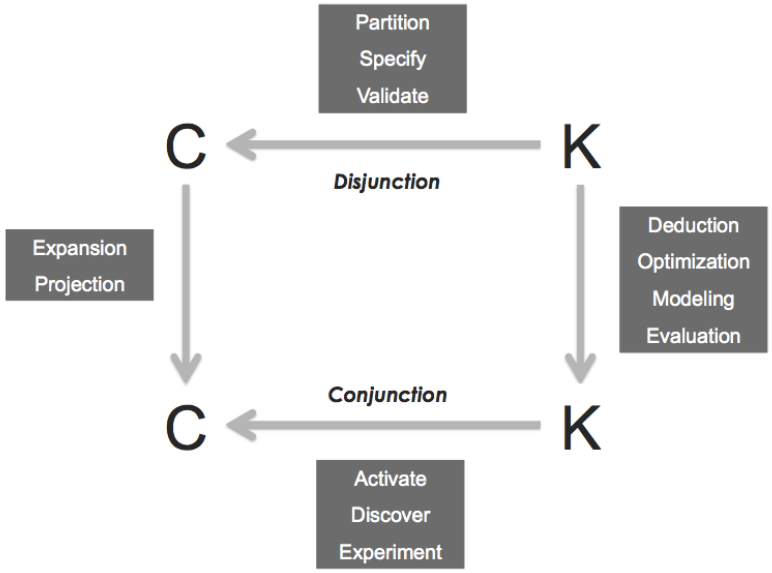
⇒ CK theory
⇒ To help defining priority topics based on action strategies possibly of interest in the field

3. Methodology

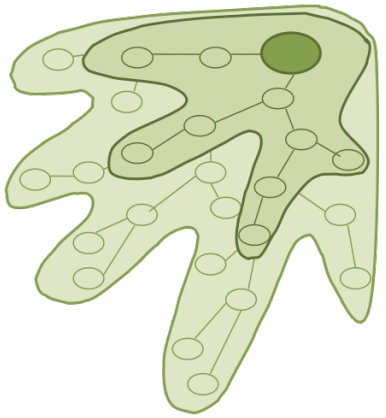
CASE ANALYSIS

- In order to study the interplay between disciplines when designing cross-disciplinary research programs, and especially to model the crossing between knowledge, we use the C-K design theory *(Hatchuel & Weil, 2003, 2009)*





3. Methodology



CASE ANALYSIS

- The **quality of a C-K exploration** can be evaluated through the **V2OR tool** :
  (Agogué, Hooge, Arnoux, Brown, 2014)
- To study the **quality of the projects** (final outputs of the metaprogram workshops), we also use V2OR tool :

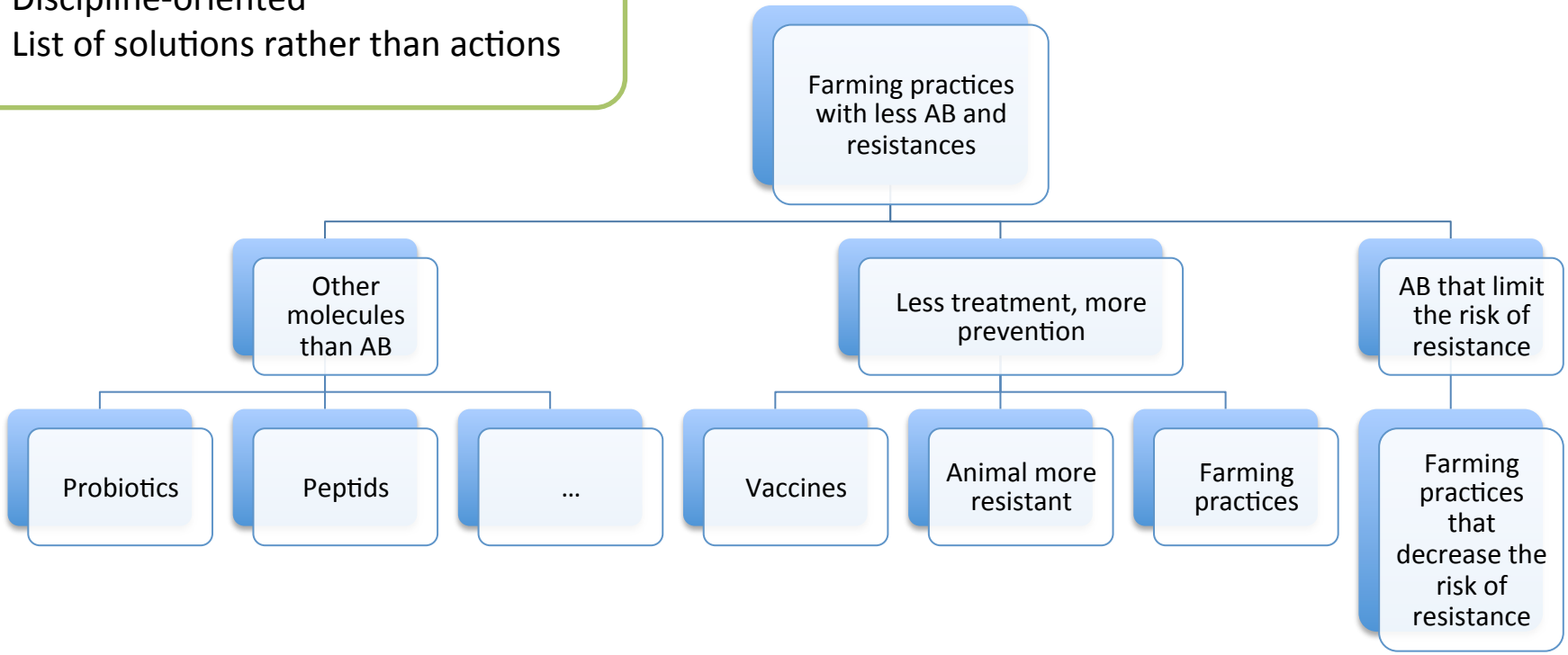
	Variety	Value	Originality	Robustness
CK tree	A good balance between height and width	Emergence of new stakeholders	Important amount of expansive C/K	Concepts are resistant to context change
Projects	Reflects the cross-disciplinary aspect	Reflects the emergence of new stakeholders (ex: farming industries)	Shows the benefits of the metaprogram structure	Shows a wide range of applications

4. Results

RESULTS PRESENTATION

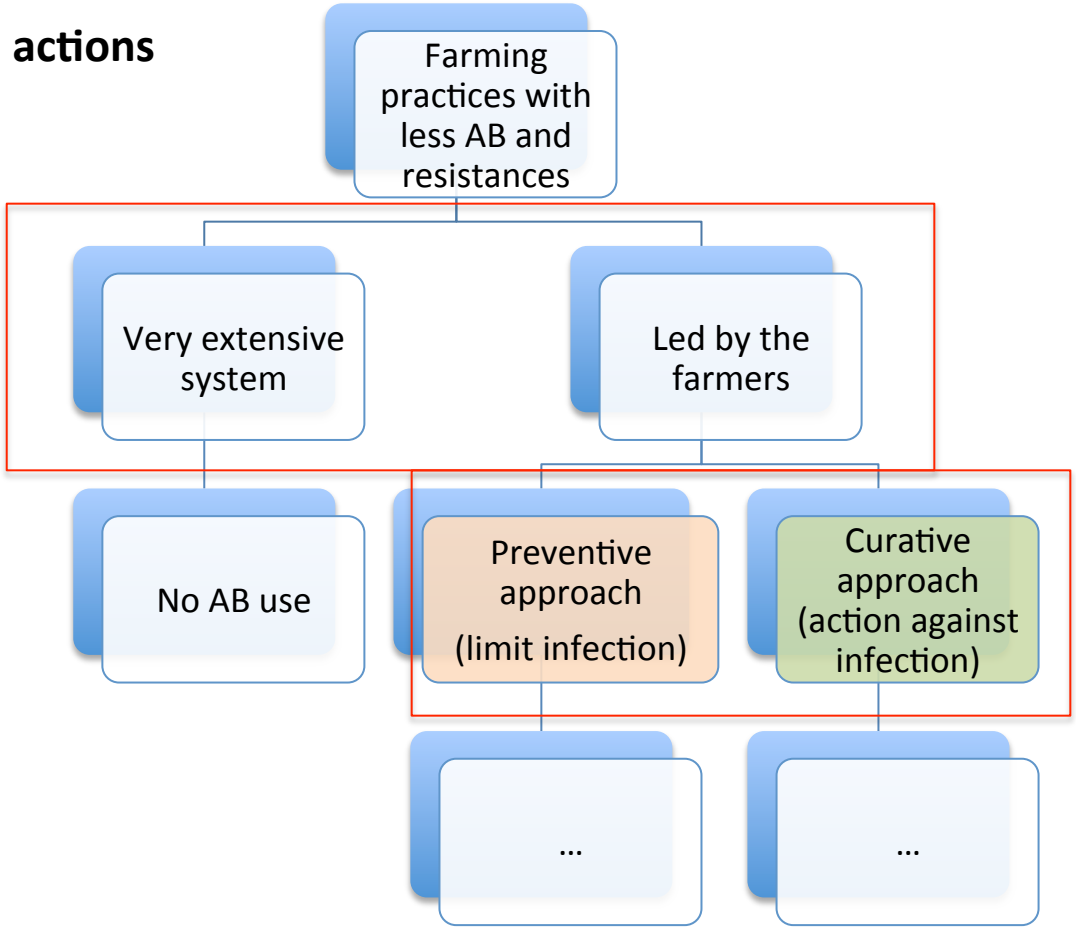
First CK

⇒ Discipline-oriented
⇒ List of solutions rather than actions



4. Results

New CK based on actions



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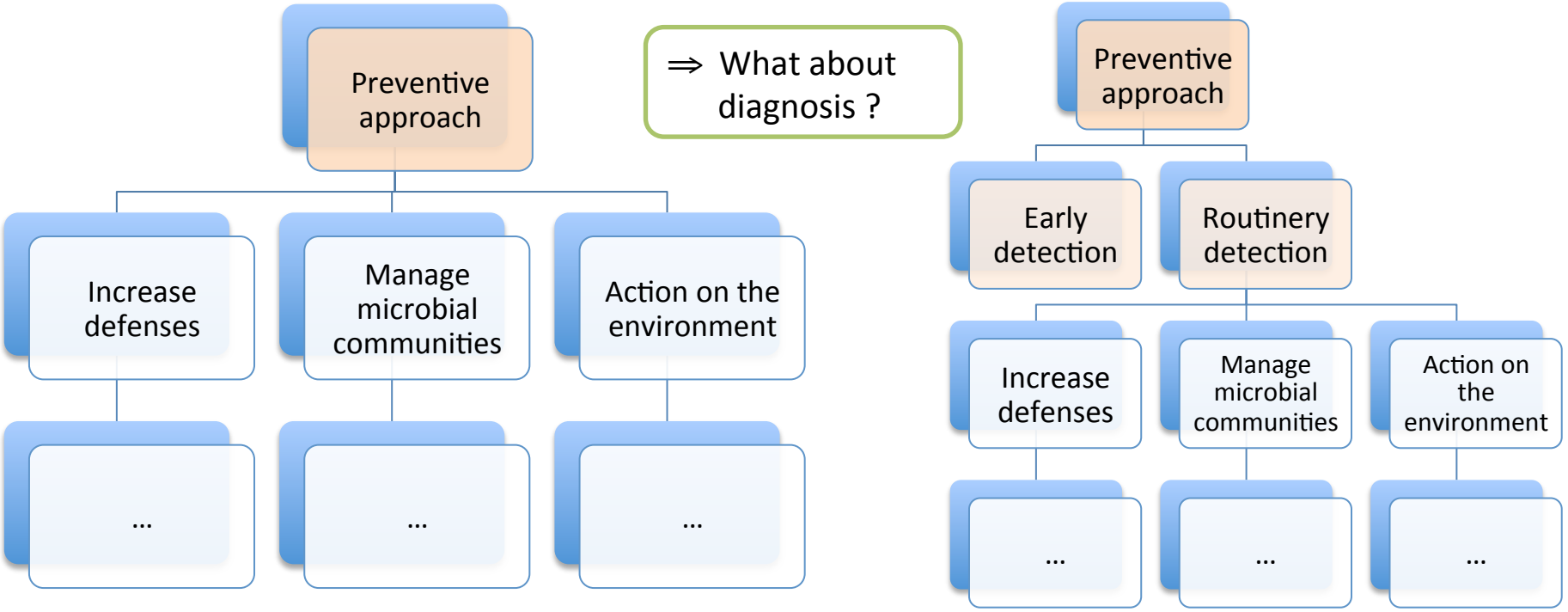
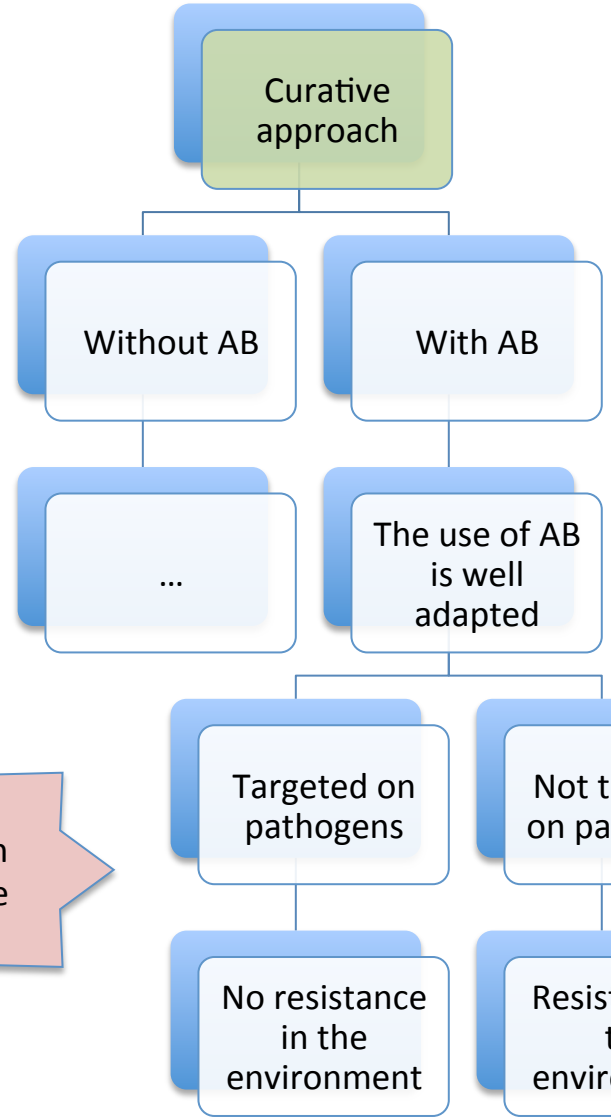


4. Results

⇒ Concepts of interests
⇒ Leading to workshops, projects, connections between disciplines



TRAJ Project

Understand the use of AB by farmers

3 workshops

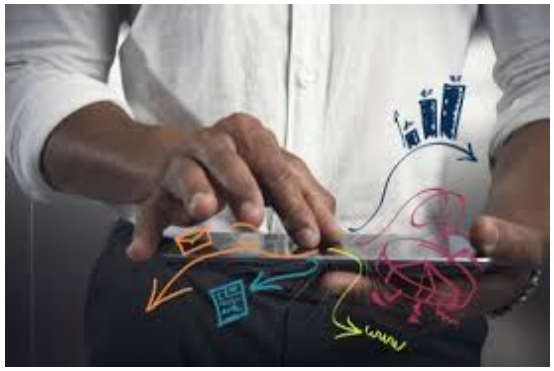
Precision medicine

AB without any impact on the digestive microbiota

RESET Project

Managing resistance in the environenment

4. Results



MEETINGS

8 meetings since February 2013
About 30 to 40 attendees per meeting

Scientific questions addressed

- Mechanisms, fitness and spreading of resistances to antibiotics
- Managing change in farming practices
- Microbiote and innate immunity
- Better use of antibiotics on farms - metaphylaxy

Field topics discussed

- Main demand for research in the different farming industries, concerning antibiotic use and resistance to antibiotics,
- Introduction to Swine industry
- Introduction to Cattle industry

4. Results

PROJECTS

1) TRAJ Trajectories of change in antimicrobial use in livestock productions, *N Fortané et D Torny,* funded

12 research teams

Disciplines : **Social sciences & Animal and veterinary sciences**

2) Spreading of resistance to antibiotics along the food chain, A *Cloeckaert & B Doublet - in prep*

3-4 teams

Disciplines : **microbiology, epidemiology**

3) RESET Use of microbiote from healthy animals for disease prevention, *O Zemb - funded*

4 teams

Disciplines : **microbiology, nutrition, pharmacology**

4) Method to tag resistance genes on bacteria strains (purpose to further develop studies on spreading of resistance), *O Zemb – submitted not funded*

5 teams

Disciplines : **microbiology, nutrition, pharmacology**

4. Results

RESULTS ANALYSIS

V2OR analysis of C-K trees

- **First CK** : low variety and originality, no new players except farmers
- **Last CK** : high variety and originality (early detection), new players (veterinarian, laboratories, farmers, technicians, suppliers, environment)

V2OR analysis of the metaprogram's outputs

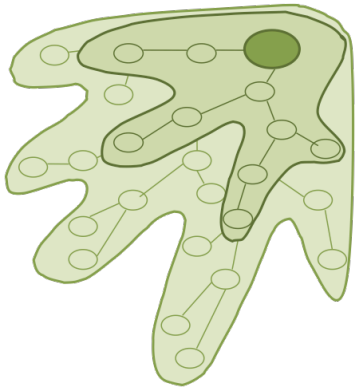
- Good **variety** *(Social sciences, veterinary sciences, microbiology, epidemiology, nutrition, pharmacology)*
- Better **originality** than with disciplinary approaches *(RESET)*
- **Value**: emergence of new players, and also value **for researchers**
  => high number of teams involved, funded projects
- **Robustness**: good resistance to context change *(species, antibiotics, bacteria)*

4. Results

RESULTS ANALYSIS

- The **quality** of the different C-K has **increased over time**.
  This essentially results from different **logics of partition** (knowledge crossing):

  1/ Disciplines by disciplines
  2/ Using existing links between disciplines
  3/ Creating new links between disciplines



- From a management perspective: **important learning costs**
  - to master the use of C-K theory
  - to **avoid "disciplines by disciplines" partitions**

- The analysis of the projects : **the cross-disciplinary aspect is actually present**
  (variety of disciplines – emergence of new players – good results in terms of originality)

5. Conclusion

- Design theory allowed to **model knowledge/disciplines crossing**
  ⇒ enhancing the design of cross-disciplinary research programs

- The **best C-K** trees were those **creating new links between disciplines**

- **3 logics of partitions, for knowledge/disciplines crossing that imply different:**
  ⇒ Generative effects
  ⇒ Difficulties to capitalize (academic publication)
  ⇒ Difficulties to organize

- From a management perspective, **learning costs** are required to developed such methods and master their uses.

Thank you !

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