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Fakultät für Naturwissenschaften und Technik
Facoltà di Scienze e Tecnologie
Faculty of Science and Technology

Reflections on the Validity of the Studies in Agricultural Engineering

Approaches and perspectives for teaching and graduate studies in this field

The Future of University-Based Agricultural Engineering in Austria
BOKU – Wien
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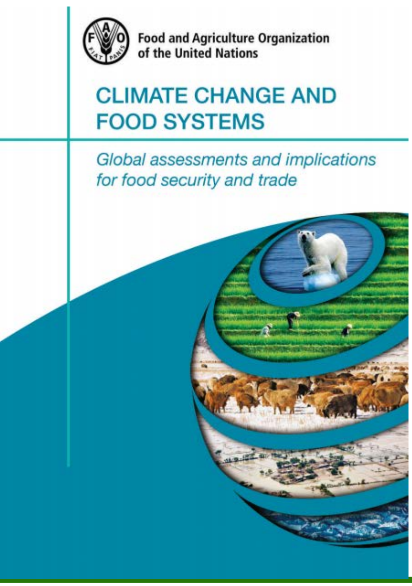
Towards a Climate-Smart Agriculture (CSA):

- **CSA** : a new global paradigm proposed by the **FAO (2015)°°** to face the problems of primary productions in an ever changing world

- **CSA→ Innovative guidelines** compatible with the requirements of **food safety** and **environmental sustainability** in contexts more and more affected by **adverse climatic changes**



- **increasing productivity sustainably**
- **enhancing resilience (crop adaptation)**
- **reducing/removing GHGs (mitigation), where possible**

- The **implementation strategies** of these goals vary from country to country

FAO, 2015. **Climate change and food system - Global assessment and implications for food security and trade**. *Ed. by A.Elbehri, Economic and Social Development Department, Food Agriculture Organization of the United Nations (FAO), I4332, pp.357.*

CSA in Industrialized Countries

- CSA matches the need to develop **technological innovations** for supporting a **sound management** of production systems

- Strong focus on: **1)** *waste control (energy- and input-saving)*, **2)** *tight profit margins*, **3)** *rational management of technologies,* often associated to a planned maintenance program

  - New **low cost** and **low environmental impacts** production systems (relevant roles for hard- and bio-technologies);

  - Adopt **advanced forms of management** to improve *products quality*, *work efficiency*, *cost reductions* through better **control** tasks (relevant roles for **ICT** and **MIS** = Management Information Systems)

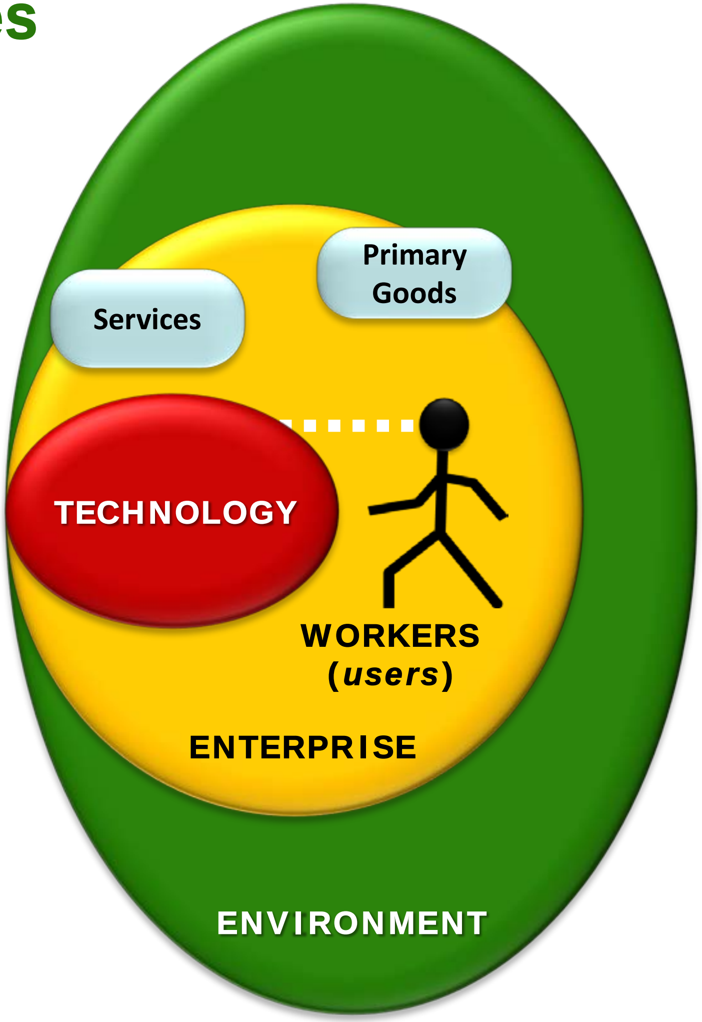
  - Greater attention to workers' **safety** and **comfort** conditions in their work environment

  - Provide a reasonable **transparency** of the enterprise conduction through **product and process certifications** (ICT + MIS)

CSA in Industrialized Countries

- Extension of the concepts of "*agriculture*" and "*farm*“
- **Agri-environmental Enterprise (AEE)**: with **cyclical** activities (besides transports) performed through **mobile field processes** (with moving machines), in work contexts that cannot be kept under predefined controlled conditions due to **meteorological and land variability**
- **Products** : can be both **primary goods** and/or **services** dealing with **natural and/or biological components**

❖ **Farms, Forestry Enterprises, Collecting Centers (*social wineries, product consortium, food processing industries…*), Contractors, Parks, Public Gardens & Green Areas, Sport Centers…**



Agr.Engng in a CSA perspective

- Is still **valid** nowadays the term Agricultural Engineering (**AgEng)**?
- Structure and objectives of its related international association (**CIGR**) are **fully coherent** with the CSA's needs and aims
- The **Mission**: «*...to serve - on a world-wide basis and through its members - the needs of humanity by fostering mutual understanding, improvement and rationalization of **sustainable biological production systems** while protecting **nature** and **environment** and managing **landscape** through the advancement of **engineering** and **allied sciences...*** »
- The adjective «**Agricultural**» doesn't focus on a specific domain of interest (= *cultivated lands*), rather addresses to the wider concept of «***biological production systems*** »

Agr.Engng in a CSA perspective

PRIMARY GOAL

Biological production systems (*sustainable*)

AGGREGATED GOALS

Nature
Environment
Landscape

TOOLS

Engineering
Allied sciences

CIGR SECTIONS

1. Land & Water Engng

- Their use in agr. & rural areas
- Conservation of resources
- Preservation and re-establishment of environmental balances
- Socio-economic impacts

2. Structures & Environment

- Rural buildings
- Interactions of biological systems with their sorroundigs
- Human/animal health and welfare
- Land planning

3. Equipment Engng for Crops

- Equipment design, manifacture & use
- All life plant steps included
- Improved productivity, & sustainability efficiency

4. Energy in Agriculture

- Production & use of energy (electricity), focus on stationary user-points
- Energy saving
- Renewable energy sources
- Energy balances

5. System Management

- Management and Systems Engineering
- Mechanizations & Work organization,
- Efficient Planning processes & Logistic
- Ergon. & Worker's safety

6. Bioprocesses

- Postharvest Technology & Process Engineering
- Agri-food processing (product properties, unit operations, equipment)
- Product Quality & Safety
- Traceability

7. Information Technologies

- Use of ICT in all Agr. Fields to enhance sustainability & profitability
- Farm Information Systems
- Sensors, Automation & Precision Agriculture

Autonomy & interdisciplinary nature of sections

- The first 3 sections reflect the original CIGR's articulation and identify domains of interest substantially **independent and circumscribed**

- Sections 4 and 6 propose new domains to meet needs for **specialization**; have clearly **circumscribed** areas (*energy production, post-harvest, food technologies*) but with **partially cross-application methods** to other areas

- Sections 5 and 7 propose **highly transversal** domains with **fully cross-applications** with all the previous areas; born as a predominantly **methodological domains**, for *management purposes*, in the wake of the experiences of *Operations Research* and *ICT*

Some open questions

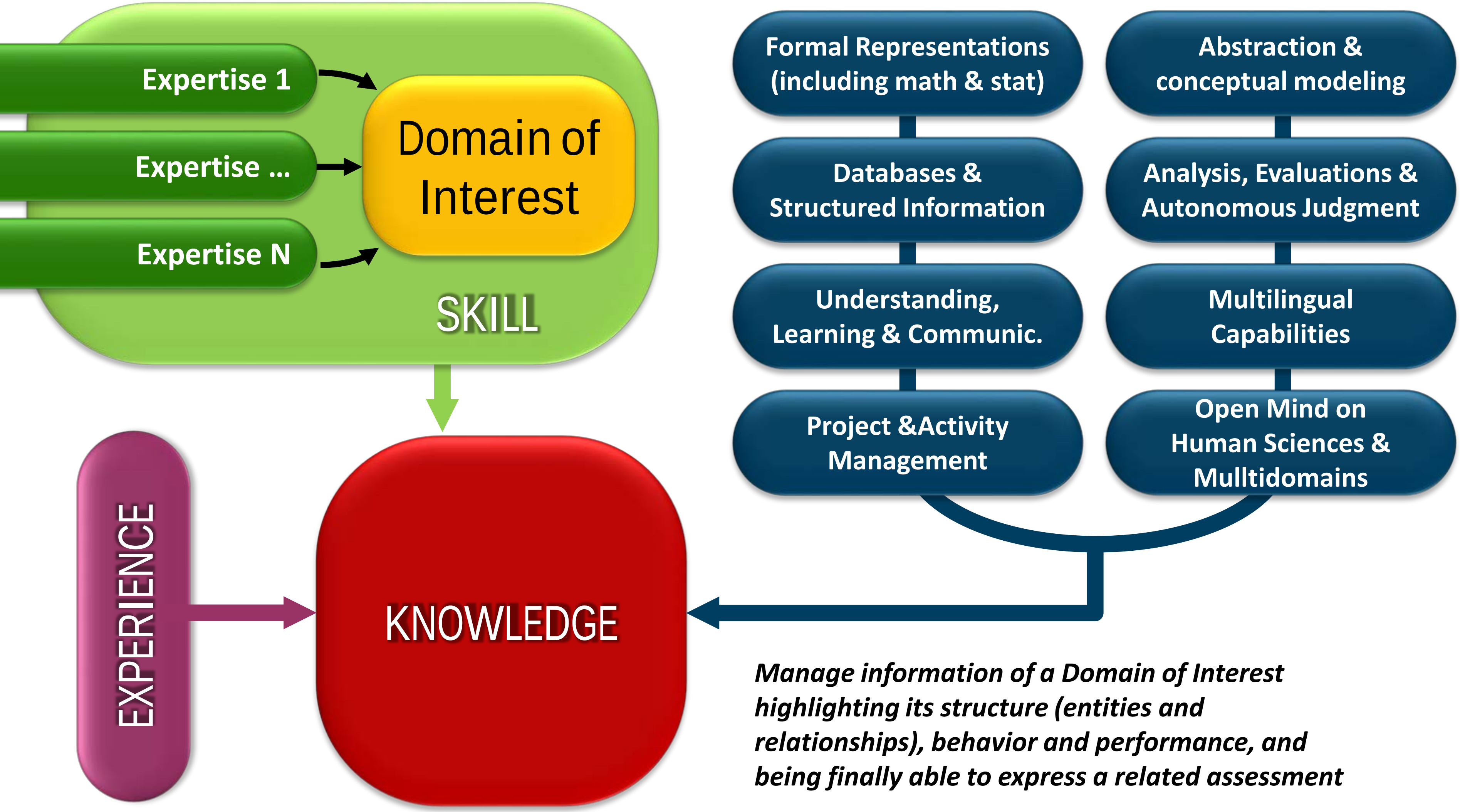
- What could be the AgEng's contribution in strengthening **Research** and **Teaching**?
- What's its role in creating new **skill**, **knowledge** and professional profiles?
- AgEng includes many **interdisciplinary interactions** within both the AgEng itself and other autonomous disciplines; sometimes it's difficult to frame the nature of such interactions, and a more **formal approach** could be useful to argue on both Research and Teaching tasks

Focus on some concepts:

- **Domain of Interest** : portion of the **real world** on which we have *application aims* (pure cognition, designing, planning, control ...)
- **Competence**: what one is able to do **effectively** with respect to a given *objective* (practical activity and / or intellectual);
  - **Expertise**: when limited to a given **professional field**;
  - **Cross-Competence**: when it is generally valid and transversal to **all sectors**
- **Skill**: a set of competences *(expertises)* in a given domain of interest
- **Knowledge**: set of *skills* and *cross-competencies* supported by different levels of **experience**

Expertises

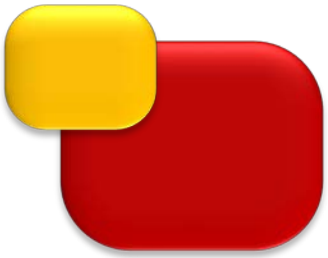
Cross-competences



Manage information of a Domain of Interest highlighting its structure (entities and relationships), behavior and performance, and being finally able to express a related assessment

Some considerations, perhaps obvious but useful…

- University courses are *educational paths* that create new **knowledge** around a given **domain of interest** (**<u>DomInt</u>**)



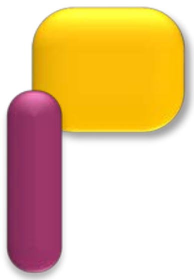
- Their organization depends on the DomInt at hand; they are firstly articulated on teachings focused on **sector-related EXPERTISEs**, while ensuring *a proper level* of **CROSS-COMPETENCE** topics

- Higher the **interdisciplinary** profile of the DomInt, *more robust* the training in **CROSS-COMPETENCE** topics

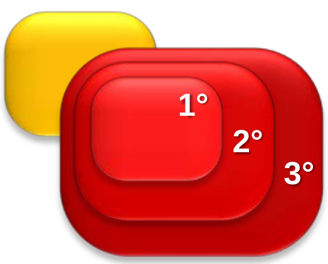
Some considerations, perhaps obvious but useful…

- Some **CROSS-COMPETENCE** topics (databases, modeling …) are still *erroneously believed to be of prevailing relevance for the Comp.Science DomInt* only, while are indispensable for all the DomInt

- University courses must grant and promote the formation of an autonomous **EXPERIENCE** (*placements, stages, mentoring, collaboration with enterprise networks*)



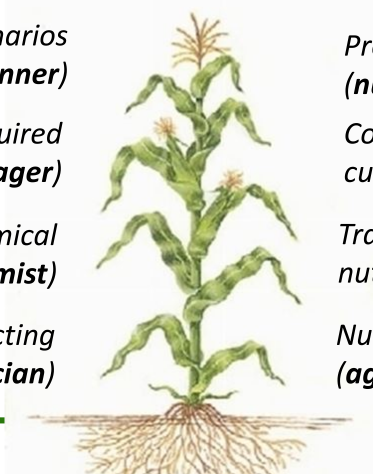
- At the end of the course the created **KNOWLEDGE** must be *demonstrated* and *observed* through some proper **indicators**, which must meet minimum requirements according to the study degree achieved



Dublin Descriptors

Domains & Macrodomains

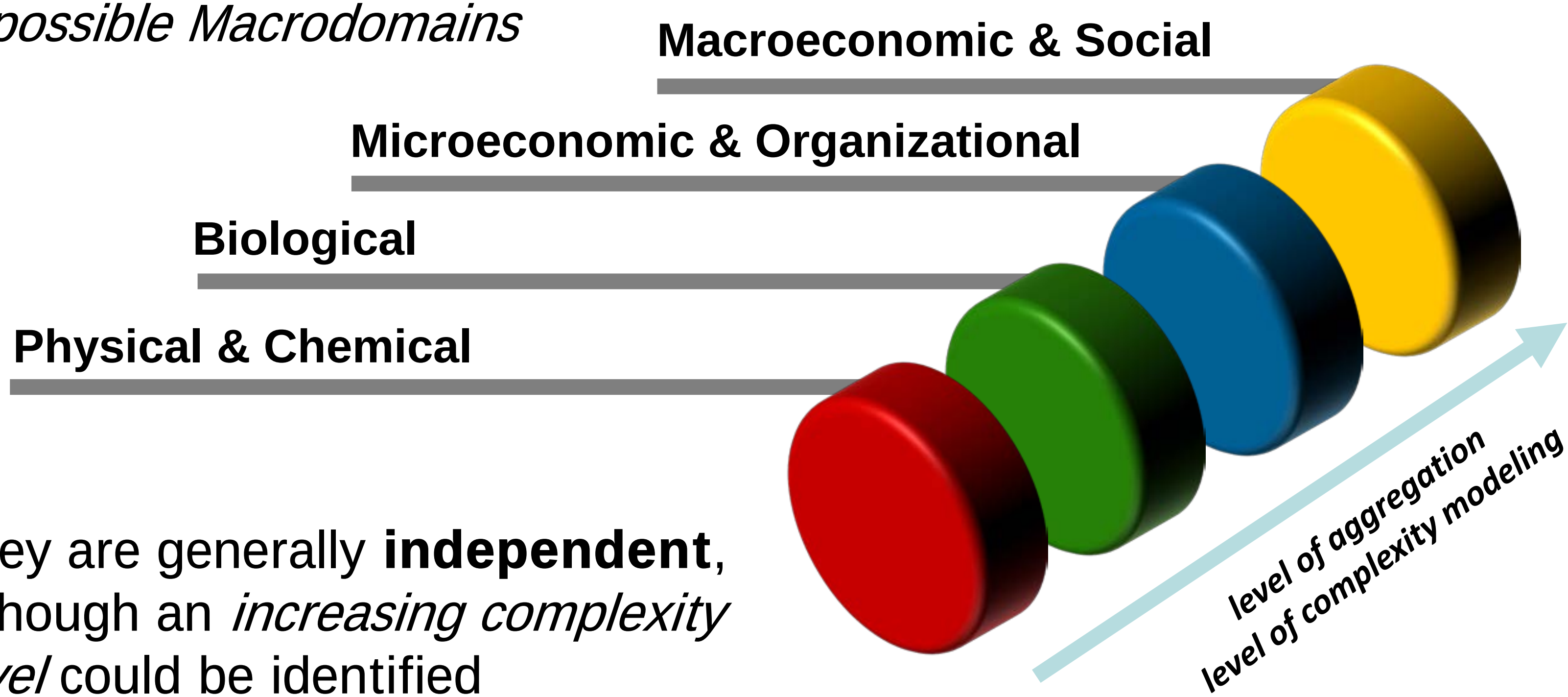
- In a Dom-Int there is thus a synthesis of several **cognitive activities** (derived from a variety of EXPERTISEs) that characterize through an **interdisciplinary** approach the aspects of interest of the real system
- But how could we appreciate the *levels of interdisciplinary*?
- **Macrodomain**: considers the general and prevailing **standpoint** by which an analysis on the **same real world** is carried out



Domains & Macrodomains

- In each **Macrodomain** the related standpoint determines the **purpose of the analysis** with the corresponding *methodological approaches*

- **4** *possible Macrodomains*



- They are generally **independent**, although an *increasing complexity level* could be identified

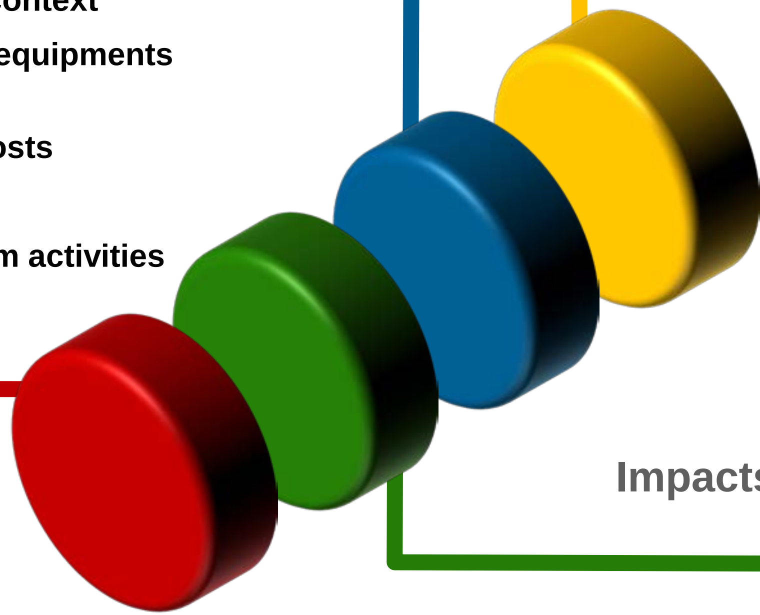
Example: Farm Equipment (EXPERTISEs and detailed expertises)

Farm Mechanization

- Design and use planning of machines and plants in a given production context
- Operational performances of equipments (worktimes and scheduling)
- Evaluation of the operating costs
- Working safety conditions
- Operational monitoring of farm activities

Market & Regulations

- Machine certifications and use prescriptions
- Market analysis
- Social impacts and acceptability degree of innovations



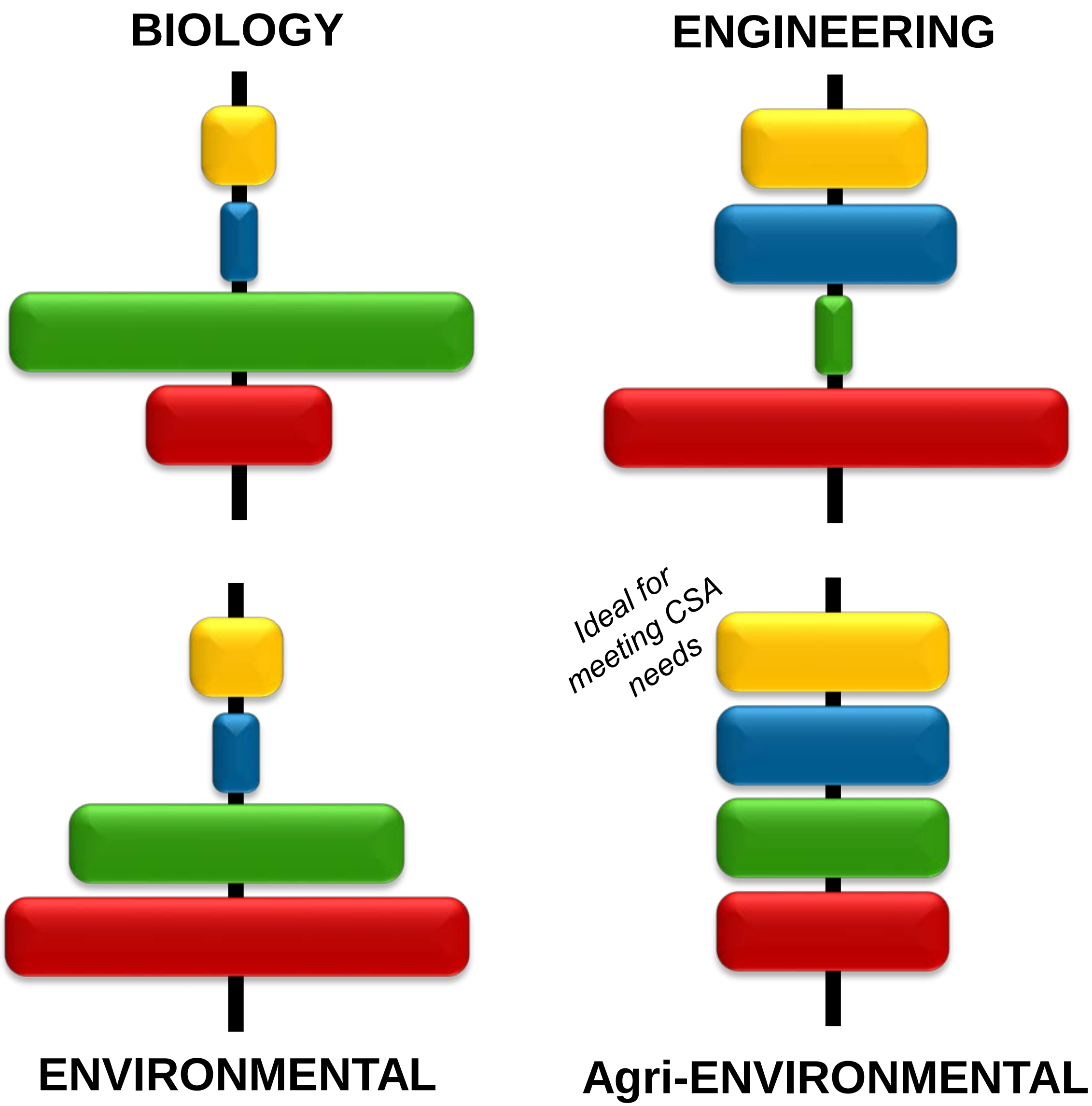
Agricultural Mechanics

- Constructive features of equipment
- Tractor/implement combinations
- Energy needs & consumptions
- Process operating principles

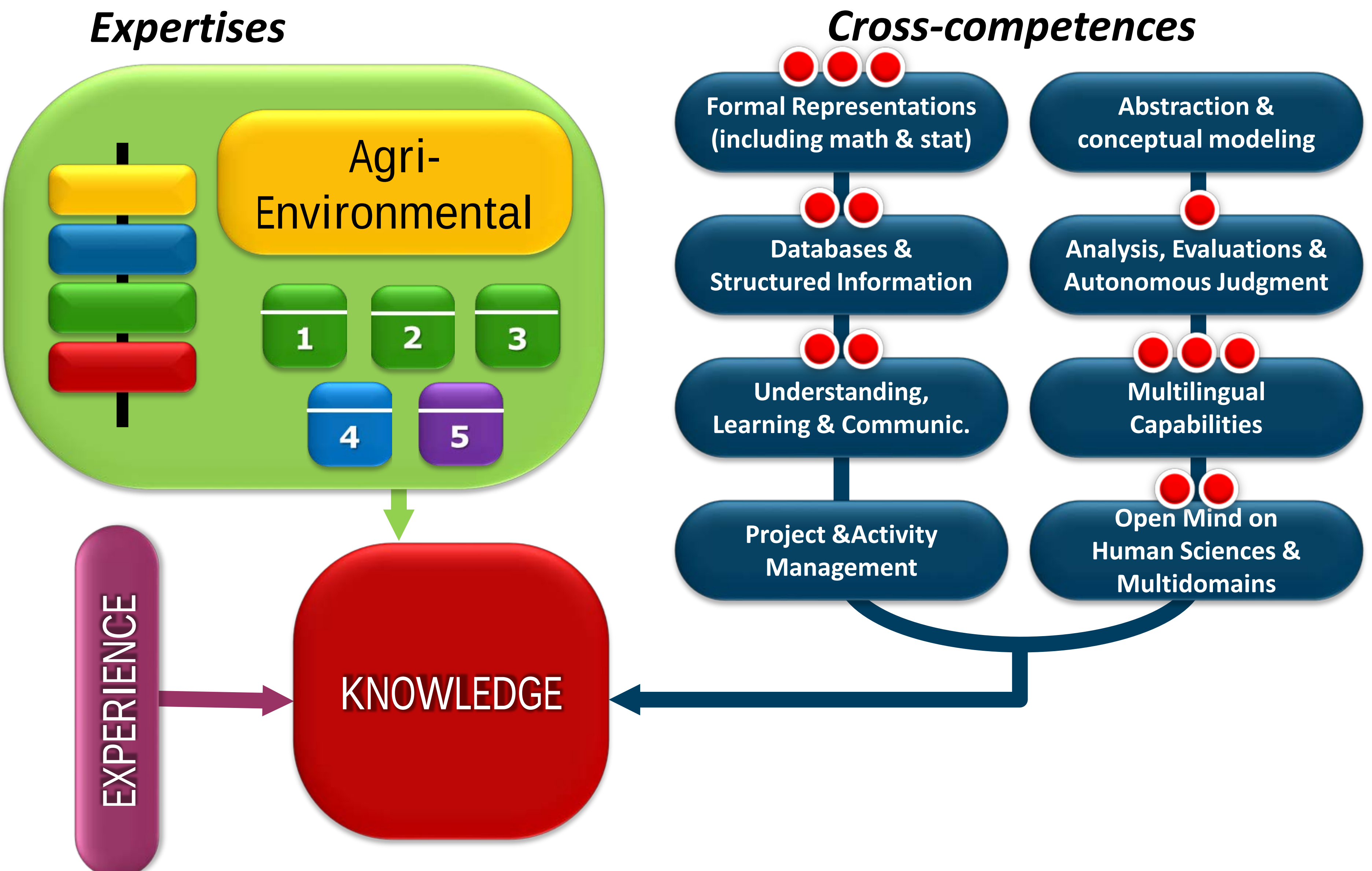
Impacts on products & environment

- Process management and quality of products
- Animal welfare
- Externalities and environmental sustainability

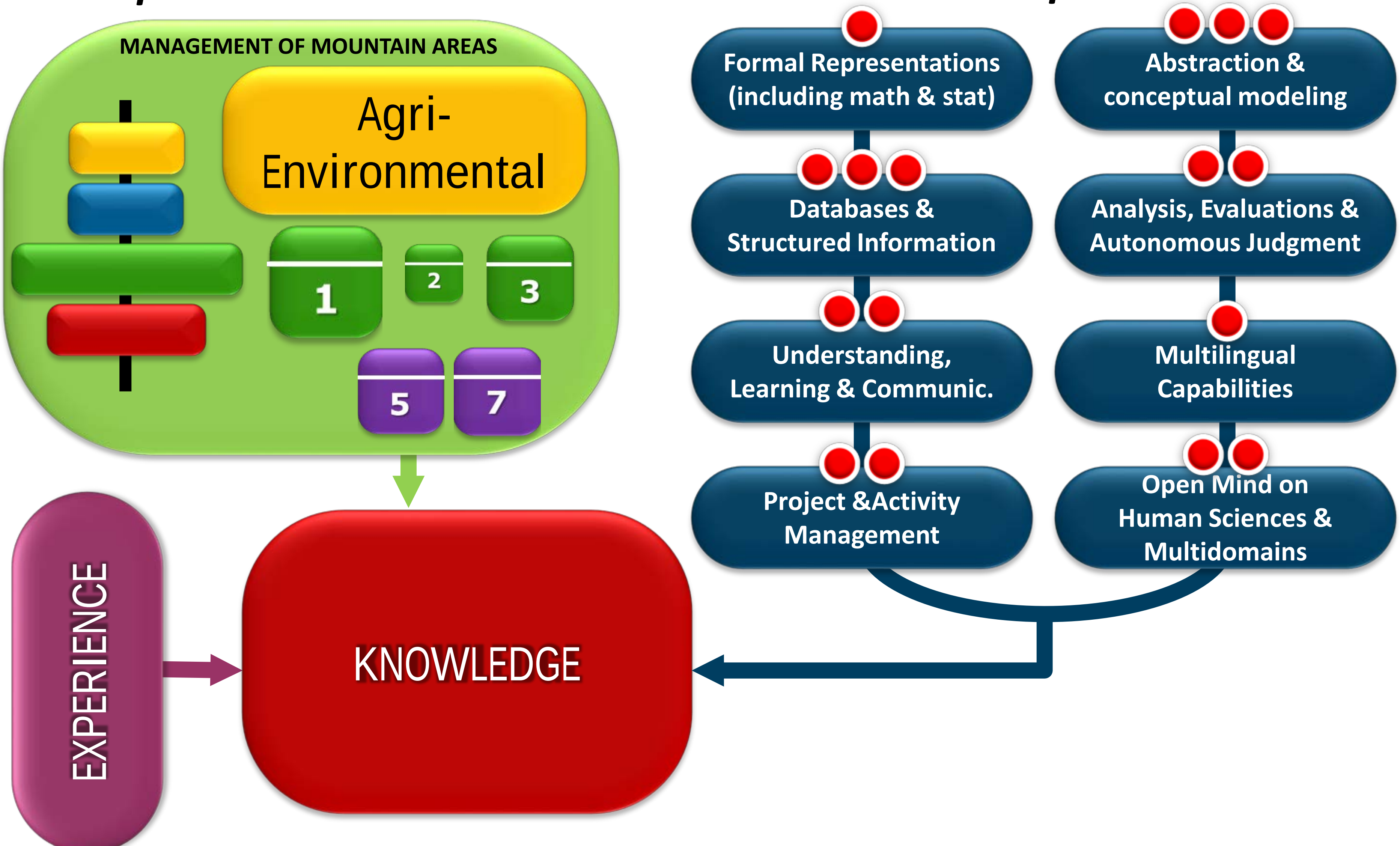
COURSES' PROFILE

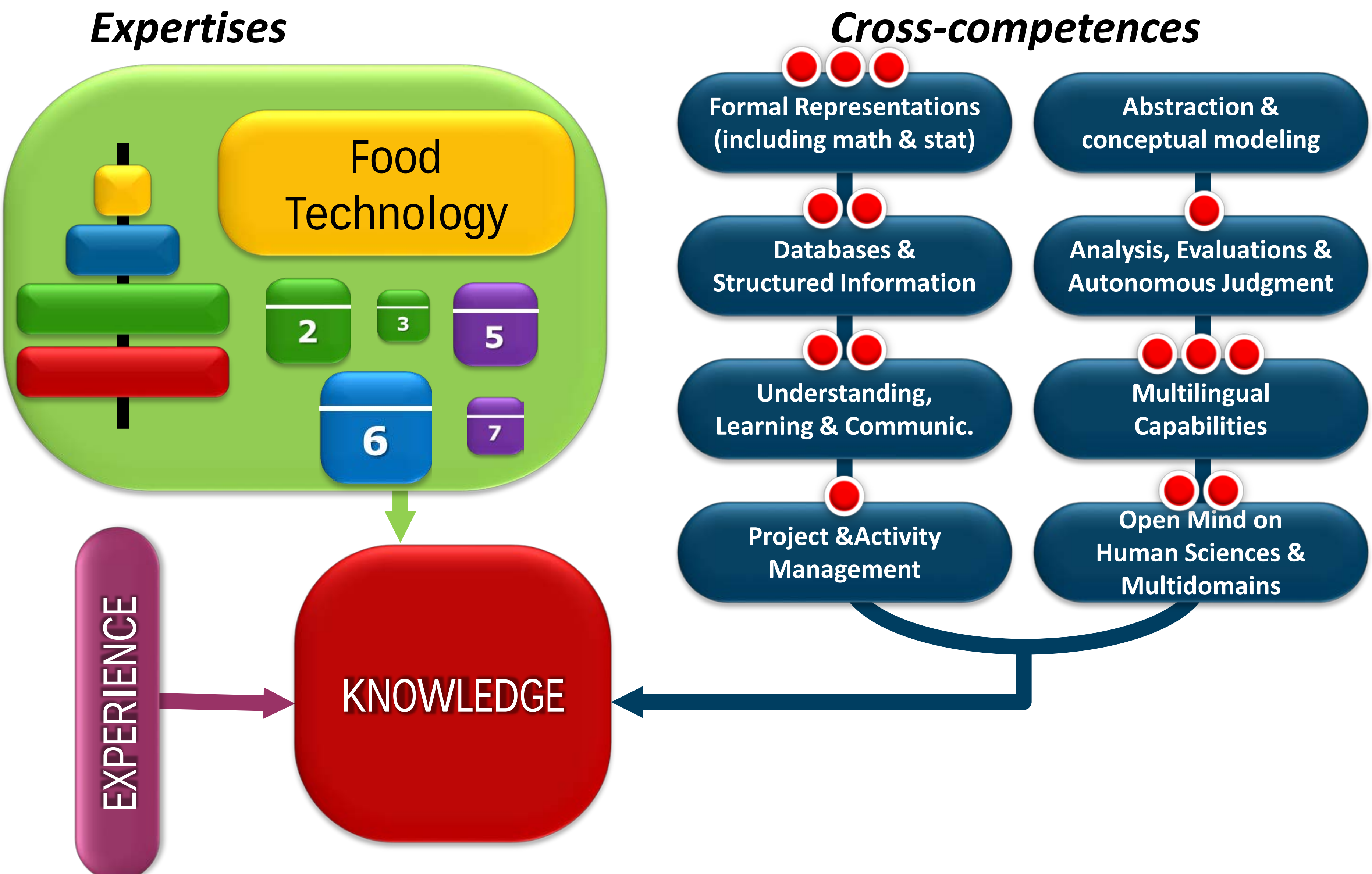


- In high specialized courses a given MD tends normally to prevail on other
- Agricultural courses should always ensure a more equilibrated profile
- The **AgEng** domains, typically very interdisciplinary, can serve as a **hinge** for this type of equilibrium
- In the past, in Italy there were study reforms that set high specialisation courses (*in bachelor programs*) → **limited usefulness, loss of professionalism, falling interest**


Expertises
Cross-competences
Agri-Environmental
1
2
3
4
5
Formal Representations (including math & stat)
Abstraction & conceptual modeling
Databases & Structured Information
Analysis, Evaluations & Autonomous Judgment
Understanding, Learning & Communic.
Multilingual Capabilities
Project &Activity Management
Open Mind on Human Sciences & Multidomains
EXPERIENCE
KNOWLEDGE

Expertises / *Cross-competences*




Expertises
Cross-competences
Food Technology
2
3
5
6
7
Formal Representations (including math & stat)
Abstraction & conceptual modeling
Databases & Structured Information
Analysis, Evaluations & Autonomous Judgment
Understanding, Learning & Communic.
Multilingual Capabilities
Project &Activity Management
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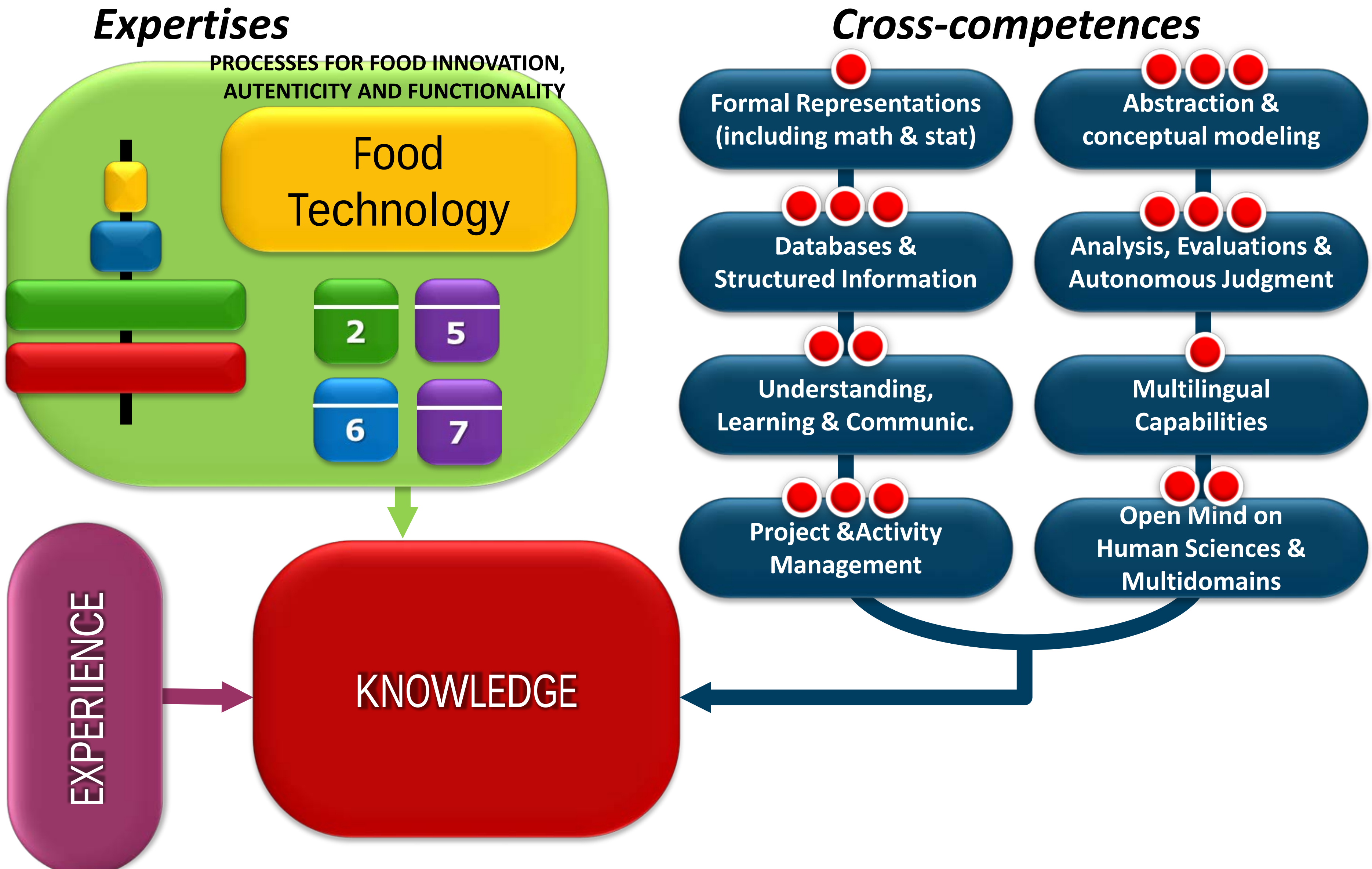
EXPERIENCE
KNOWLEDGE


Expertises
PROCESSES FOR FOOD INNOVATION,
AUTENTICITY AND FUNCTIONALITY
Food Technology
2
5
6
7
Cross-competences
Formal Representations (including math & stat)
Abstraction & conceptual modeling
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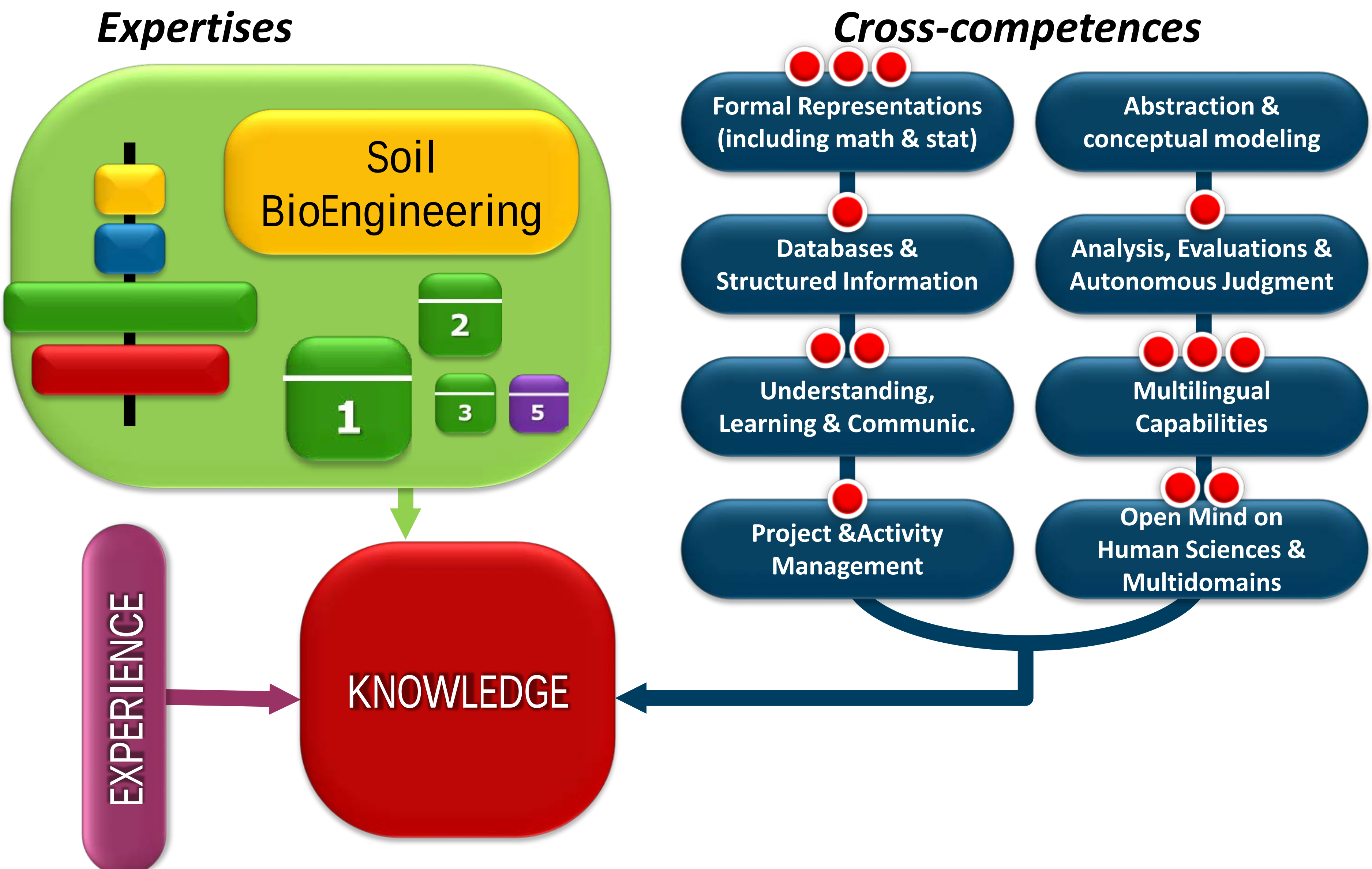
EXPERIENCE
KNOWLEDGE


Expertises
Cross-competences
Soil BioEngineering
2
1
3
5
Formal Representations (including math & stat)
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Analysis, Evaluations & Autonomous Judgment
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Multilingual Capabilities
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EXPERIENCE
KNOWLEDGE

Do AgEng topics need a minimum entry level?

- **Yes**: problems both in Bachelor (*students from a variety of not enough adequate secondary school*) and Master (*students with Bachelor programs with a null physical/technical background*)

- Proper "**alignment courses**" (*compulsory or optional*) could be planned, especially where "physics" is lack

  - **Introduction to Agricultural Engineering** (**trick**: *use the concept of* **energy** *to review fundamentals of physics through a practical approach, while entering immediately into the specific aspects of the production systems)*

  - **Fundamental of System Analysis** *(which contents should be planned according to the objectives of the bachelor/**master** course at hand, but however highlighting mechanisms of interactions among physical, biological, technical systems with the main related methodologies)*

- Where possible, «**Physics**» course contents should be planned even according to the needs of future AgEng profiles

Can AgEng treat directly also cross-competences?

- **Largely Yes**: AgEng already includes domains that are typically transversal to many contexts (→ e.g.: **7. ICT for Agriculture**)
- As Interdisciplinary promoter, AgEng should implement **new courses** *linking its own domains of interest to apply cross-competence disciplines*
  - **Farm Ontology and Data Structure Designing** *(theory of database and its application to farm organization and processes)*
  - **Farm Management Systems** *(how to treat Information at an agri-environmental enterprise)*
  - **Agri-mechatronics and Precision Agriculture** *(application of ICT and automation at an agri-environmental enterprise)*
  - **Organizational Control in Agro-Environmental Production Systems** *(providing even an introduction to the certification of quality systems and to the practice of project management)*

CONCLUSIVE REMARKS

- AgEng is the frame supporting the **technological soul** of *any biological production system*

- **Industry 4.0** is now providing a new revolution in the industrial sectors; AgEng can promote the same in the agri-environmental contexts*, thus providing practical solutions to match **CSA needs***

- AgEng often suffers the **competition** with experts from other domains; *this is normal* when a domain is shared to be treated through *interdisciplinary* approaches... Simply keep the focus on its primary goal (*technological soul of bps...*)

- Opportunity of extending AgEng even to **Life Long Learning** measures: promote innovations through seminars, summer updating courses, open day with visit and demonstration activities in labs where possible (*Lange Nacht der Forschung*) → **III Mission**