Farm-Centered Integrated Modelling for the Design of Sustainable Agricultural Systems.

Jacques Wery

With contribution from
Jean-Marc Blazy, Hatem Belhouchette, Pierre Chopin, Francois Affholder, Jacques Eric Bergez, Olivier Therond

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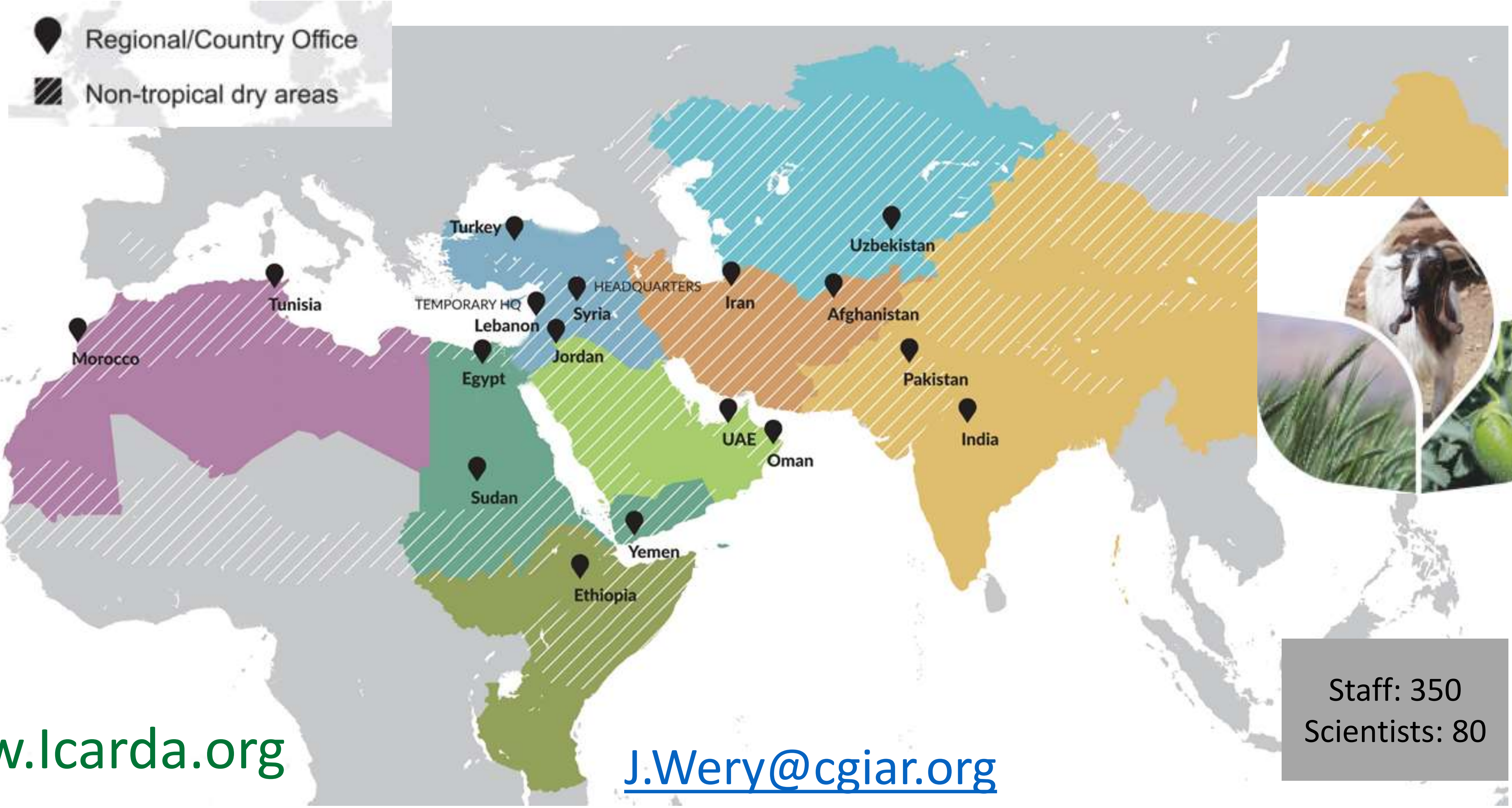
ICARDA

Achieving Impact Where It Matters



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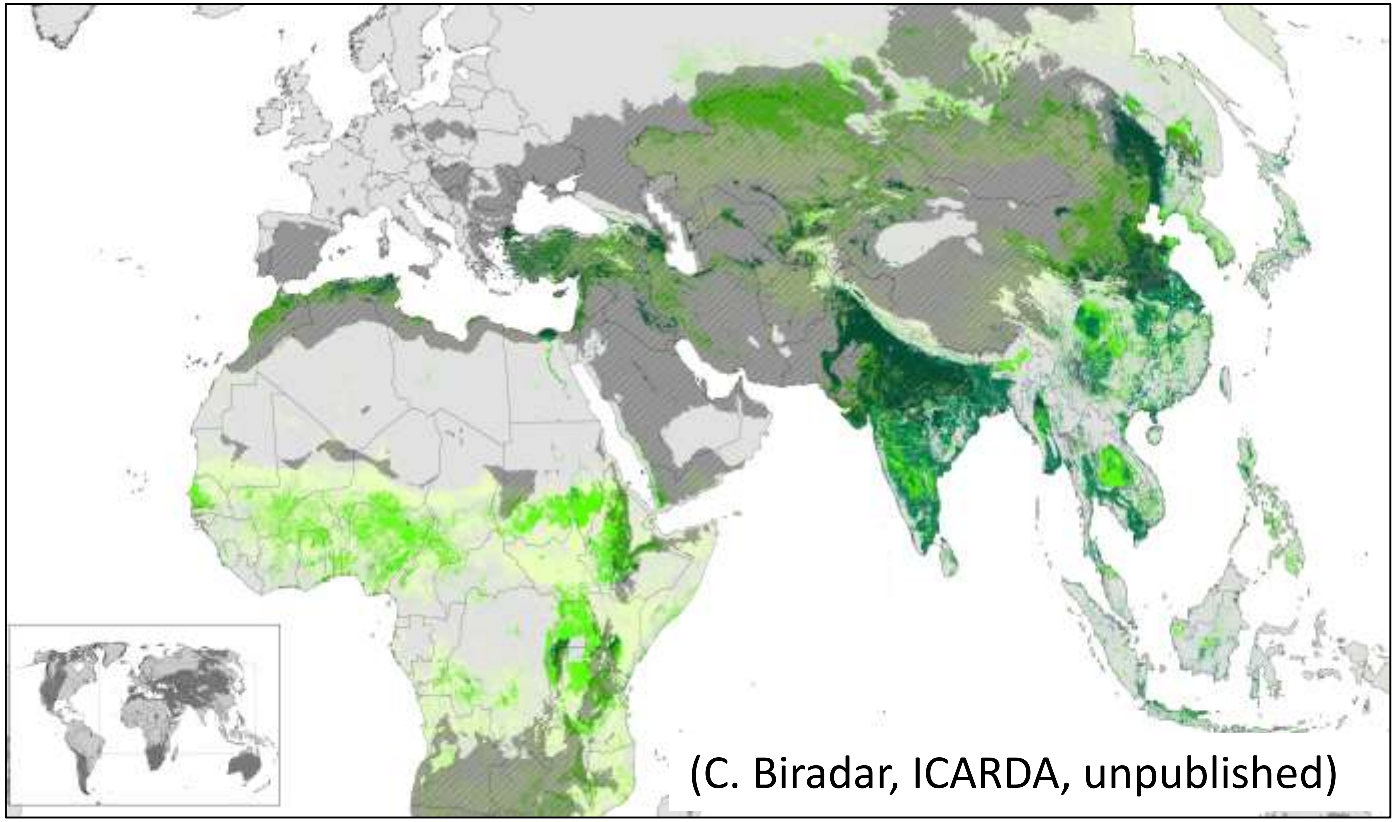
www.Icarda.org

J.Wery@cgiar.org

Outline

1. Challenges for Agriculture in the Drylands
2. The Scaling challenges for agronomists
3. “Farm-centered” Integrated Modeling
4. Way Forward

1. Challenges for Agriculture in the Drylands



Agricultural Systems
- Irrigated
- Rainfed
- Agro-Pastoral

- Food and nutrition insecurity
- Unemployment and Migration
- Women and Youth
- Increasingly drier and hotter
- Natural resources

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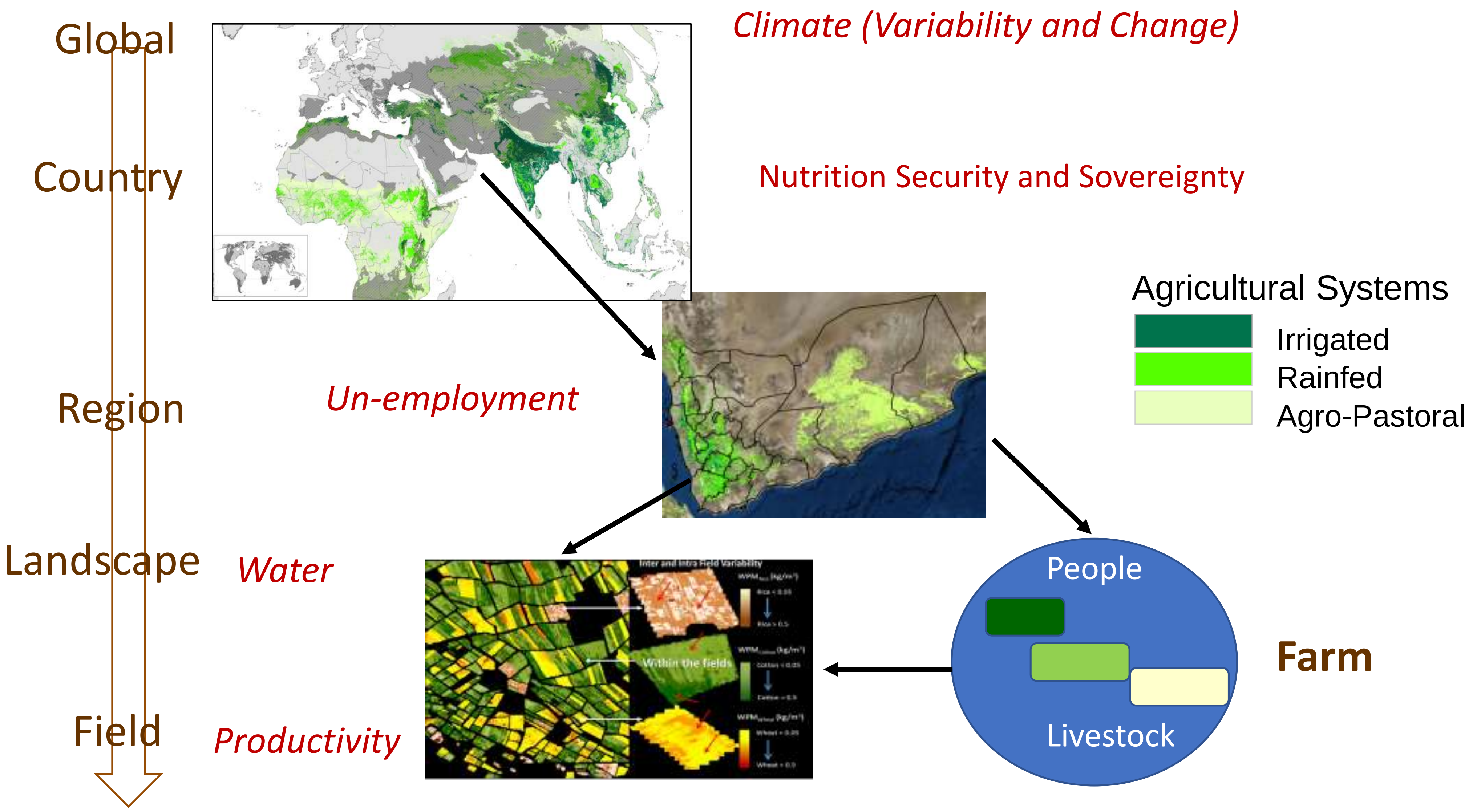
2. The Scaling challenges for agronomists: Down, Out and Up

Produce **Innovations AND Conditions** for Success

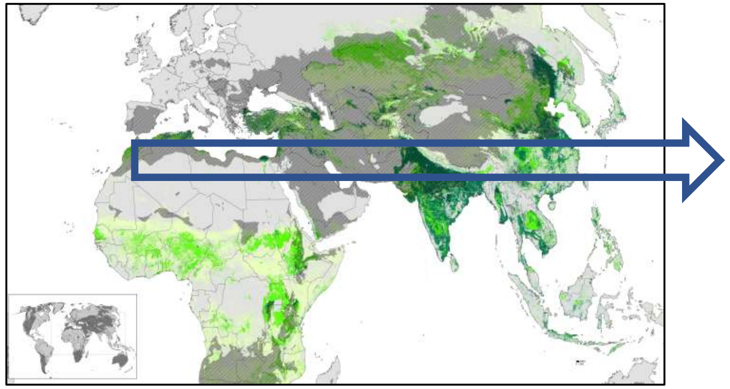
- **Multi-Scales** (compared to field)
  - Look UP for Drivers
  - Look DOWN for Processes
- **Multi-Criteria**
  - Sustainability Indicator at proper scale (landscape, farm, community, country)
- **Multi-Domain**
  - Biophysical (Process)
  - Technical (Management)
  - Socio-economic (Enabling environment)
- Document the **Trade-offs**
  - quantification
  - exploration

→ **Integration and Simulation**

Scale-down" Assessment criteria" and "Context"



Scale-Out "Innovations"



Similar Systems and Context

Mechanized Raised-Bed Planting Wheat

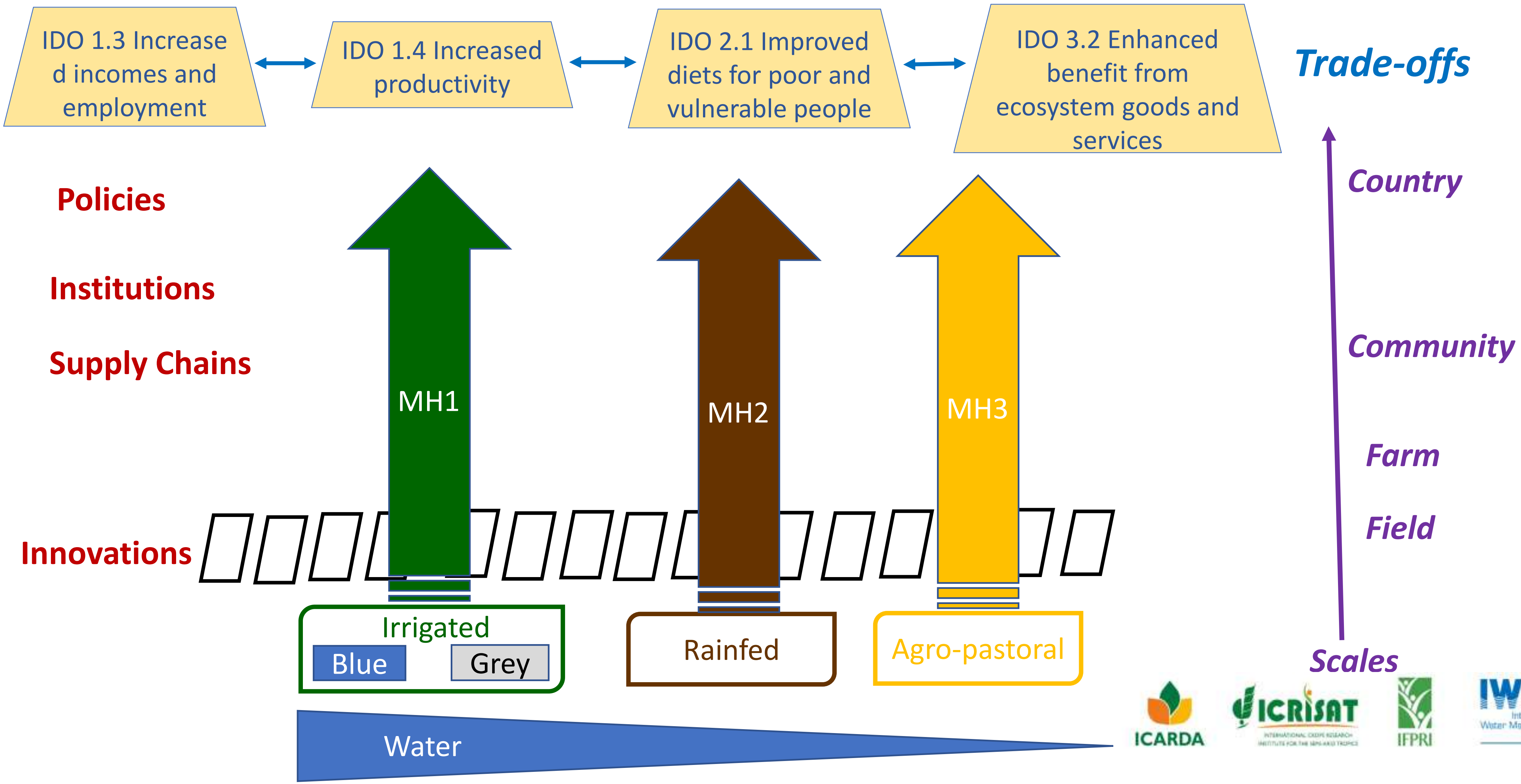
- Less irrigation water (- 25%)
- More yields (+30%)
- Less seeds (-50%)

22 governorates

10% of Egypt's total wheat area (125,000 ha)

Ethiopia, Jordan, Iraq, Morocco, Nigeria, Sudan, Tunisia and Uzbekistan

Scale-Up Impacts and Ecosystems Services



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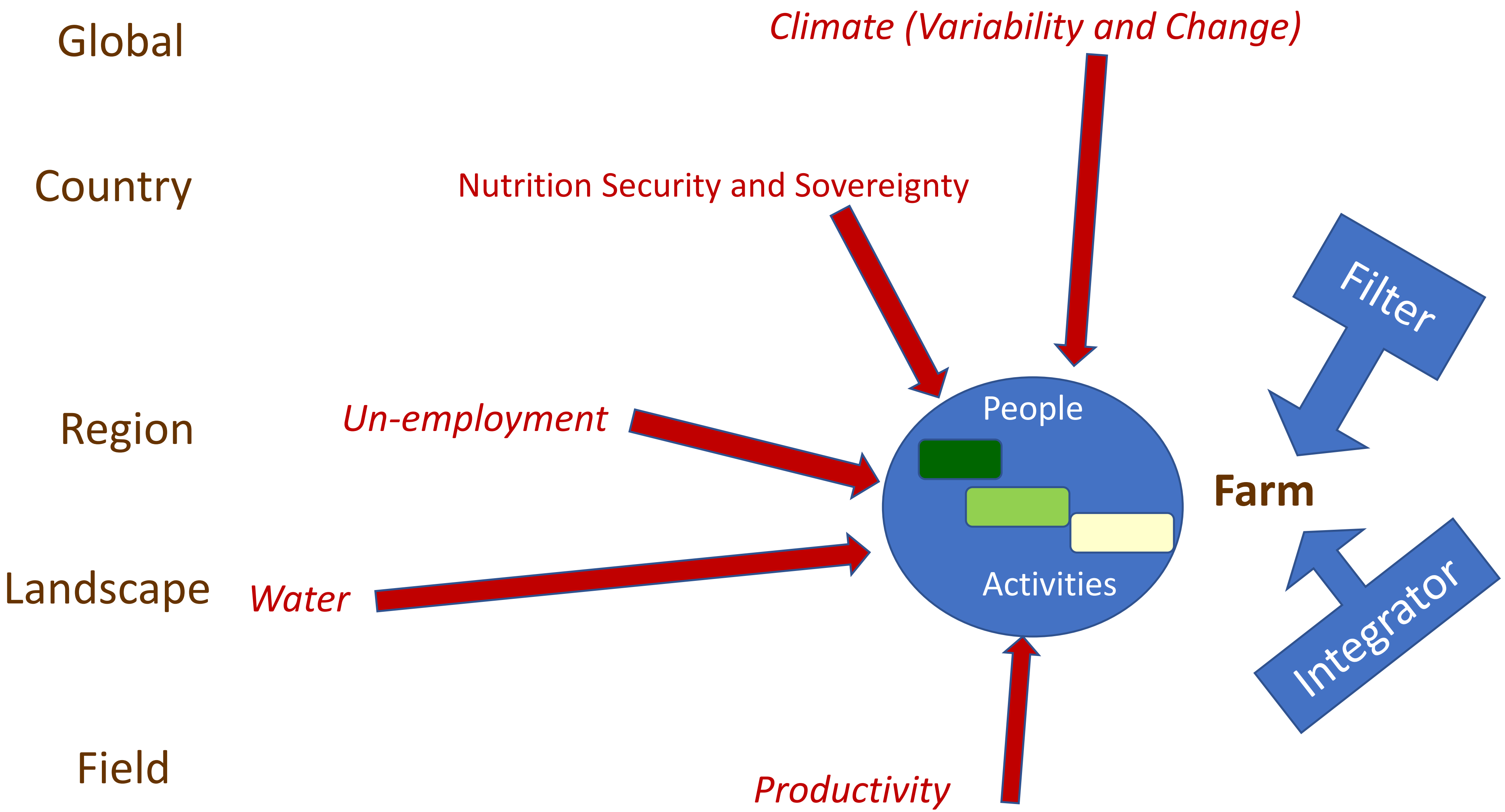
3. "Farm-centered" Integrated Modeling



The Farm as a System of Activities

Supply Chains

Labor

Four Activities

(Hammouda et al., in revision).

Rotation, Association

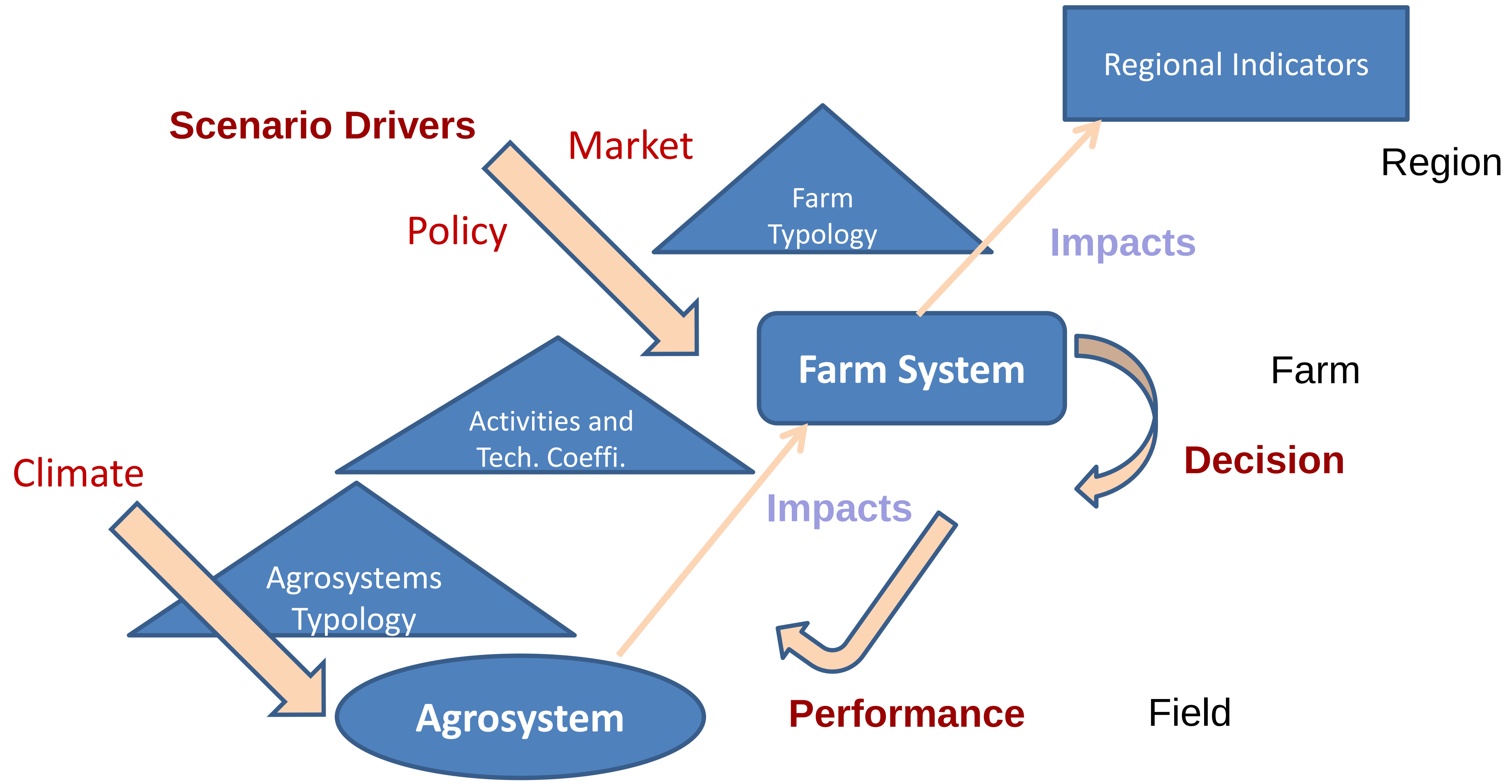
Soil, Irrigation, Size

SEMIARID Project

Several Agrosystems

(Lamanda et al. 2012 – Merot et al., 2017).

Farm-Centered Modeling chain for Cropping Systems Design in Policy, Market and Climate Contexts



(van Ittersum et al., 2008 ; Therond et al., 2009 ; Belhouchette et al., 2010 ; Delmotte et al., 2016)

Different ways to model an Agrosystem

- **Use an existing Integrated Crop Model (e.g. STICS)**
  - **Aim:** Capture the Complexity and DiversitieS
  - **Problem:** number of parameters vs. Lack of data
- **Statistical model tailored to the available data**
  - **Aim:** Reduce the uncertainty: e.g. regional yield variability depending more on farm type ?
  - **Problem:** limited validity domain (climate, low pesticides…)
- **Partial Models (e.g. BISWAT,** Bertand et al., 2018. EJA**)**
  - **Aim:** a partial view on the system but make use of all types of data and knowledge
  - **Problem:** tailor the scenario to the modeled system

(Therond et al., 2011 ; Adam et al., 2013 ; Affholder et al., 2012, Bertrand et al., 2018)

Different ways to model a Farm System

- **Technical systems (e.g. Crop Rotations) are exogeneous (e.g. Olympe):** most frequent in practice
- **Technical systems are endogeneous :**
  - **With optimisation** (e.g. **DAHBSIM**, Belhouchette et al., 2017)
  - **With Decision Rules** (e.g. **NAMASTE**, Robert et al., 2017)
- **Data are more limiting than models**
  - **Lack of databases on Activities** (Belhouchette et al., 2010)
  - **Limited access to farm individuals in global database (e.g. FADN)**
  - **Plenty but Scattered and Heterogeous data when working with individuals farmers and advisors** (Hamouda et al., in prep)

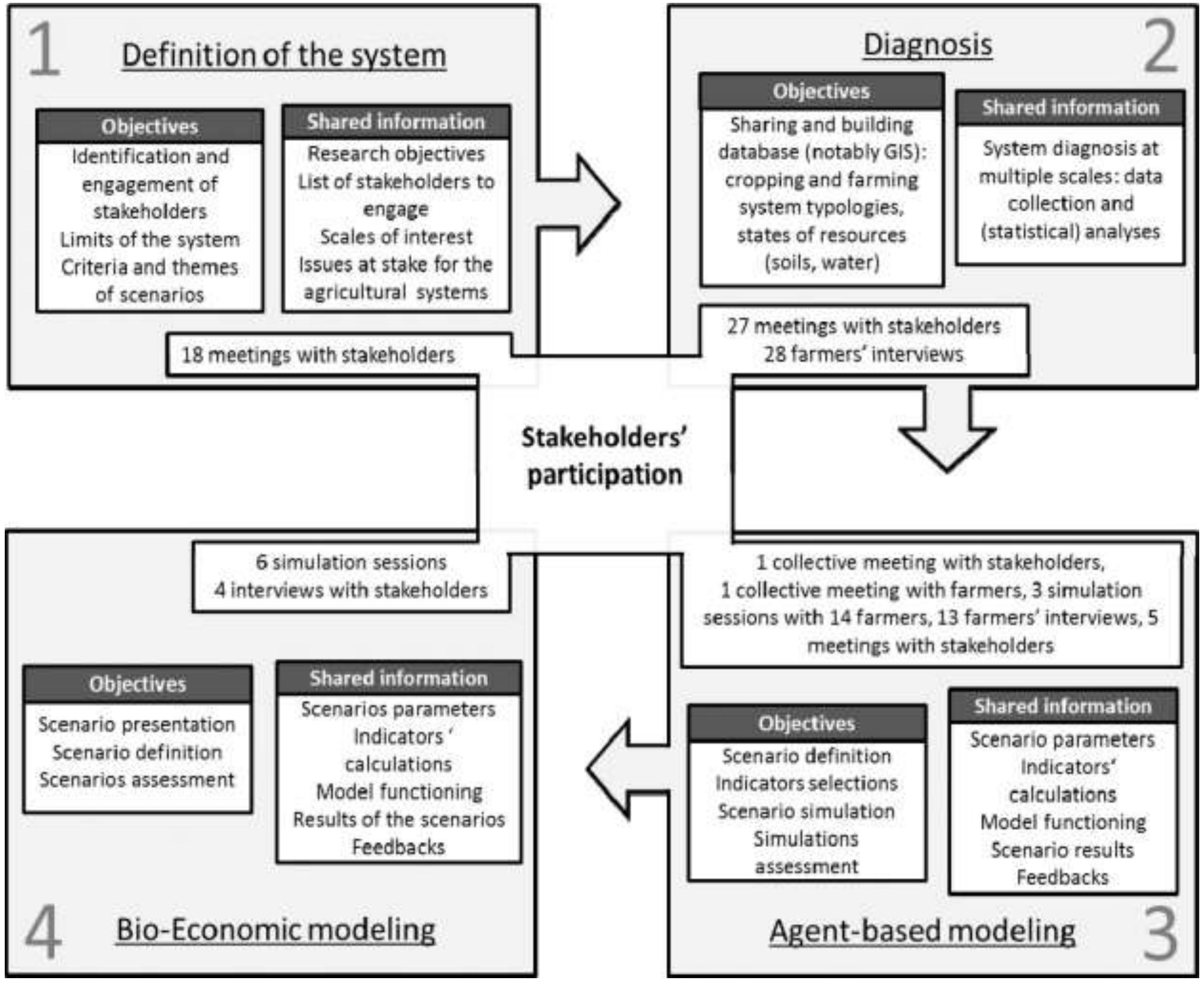
→ **How far can we go to capture farmers behaviour ?**

Typologies may be more important than models

- **Farm Typologies:** to capture regional diversity and dynamics (Structural changes) – May be the major driver of regional impact
- **Field Typologies (soil, shape, distance to farm…):** to capture management constraints and performance diversity (e.g. input efficiency)
- **Agrosystems Typologies:** to cope with the expected « re-complexification » of cropping systems: genetic diversity, intercropping, agroforestry…

(Blazy et al., 2009 ; Chopin et al.,2017; Gaba et al., 2015)

When and how to interact with experts, stakeholders and users ?



- Assessment Indicators
- Scenarios Drivers and Components
- Data collection - Credibility
- Model development – Credibility
- Development or Use of the Framework?

(Delmotte et al., 2016)

Worldwide research community on Farm-centered Integrated Methodologies

http://www.farming-systems-design.org.uy/en/

…and FSD7 – Tunisia - 2021

4. Way forward

- To have an Impact Agronomy must be scaled up
- To be operational and sustainable Agro-ecological Innovation must be scaled down to the field
- The Farm System as ‘Filter” and “Integrator” through the combination Activity-AgroSystem.
- An increasing diversity of Models and Methods
  - → Farm Centered Conceptual Framework
  - → ad hoc modelling chains
- Potential of collaboration with Europe in the Drylands

J.Wery@cgiar.org

References

- Hammouda M., J. Wery, T. Darbin, H. Belhouchette, in revision. Simulation of strategic agricultural production decisions to overcome weed resistance to herbicide treatments in south-west France. Computers and Electronics in Agriculture (in revision).
- Bertrand N., S. Roux, O. Forey, M. Guinet, J. Wery, 2018. Simulating plant water stress dynamics in a wide range of bi-specific agrosystems using the BISWAT model. European Journal of Agronomy 99 :116-128..
- Merot A., J. Wery, 2017. Converting to organic viticulture increases cropping system structure and management complexity. Agronomy for Sustainable Development 37 : 19-29.
- Chopin P., J.M. Blazy, L. Guindé, J. Wery, T. Doré, 2017. A framework for designing multi-functional agricultural landscapes: application to Guadeloupe Island. Agricultural Systems 157: 316-329.
- Souissi I., J.M. Boisson, I. Mekki, O. Therond, G. Flichman, J. Wery, H. Belhouchette. 2017. Impact assessment of climate change on farming systems in the South Mediterranean area: a Tunisian case study. Regional Environmental Change 2017 :1-14.
- Delmotte S., J.M Barbier, J.C Mouret, C. Le Page, J. Wery, P. Chauvelon, A. Sandoz, S. Lopez Ridaura, 2016. Participatory integrated assessment of scenarios for organic farming at different scales in Camargue, France. Agricultural Systems 143: 147–158.
- Hauswirth D., T. Sen Pham T., J. Wery, P.Tittonell, D. Jourdain, F. Affholder, 2015 Exploiting farm typologies for designing conservation agriculture systems: a case study in northern Vietnam. Cahiers Agricultures, 2015, 24, 2, pp 102-112, John Libbey Eurotext, Montrouge, France,
- Souissi I., J.M. Boisson, I. Mekki, O. Therond, G. Flichman, J. Wery, H. Belhouchette. 2017. Impact assessment of climate change on farming systems in the South Mediterranean area: a Tunisian case study. Regional Environmental Change 2017 :1-14.
- Lamanda N., Roux S., Delmotte S., Merot A., Rapidel B., Adam M., Wery J., 2012. A protocol for the conceptualisation of an agro-ecosystem to guide data acquisition and analysis and expert knowledge integration. European Journal of Agronomy 38:104-116.
- Belhouchette H., Louhichi K., Therond O., Mouratiadou I., Wery J., van Ittersum M.K., Flichman G., 2011. Assessing the impact of the Nitrate Directive on farming systems using a bio-economic modelling chain. Agricultural Systems 104:135-145.
- Le Gal, P.Y., Merot, A., Moulin, C.H., Navarrete, M., Wery, J., 2010. A modelling framework to support farmers in designing agricultural production systems. Environmental Modelling & Software 25: 258-268.
- Ewert, F., van Ittersum, M.K., Bezlepkina, I., Therond, O., Andersen, E., Belhouchette, H., Bockstaller, C., Brouwer, F., Heckelei, T., Janssen, S., Knapen, R., Kuiper, M., Louhichi, K., Olsson, J.A., Turpin, N., Wery, J., Wien, J.E., Wolf, J., 2009. A methodology for enhanced flexibility of integrated assessment in agriculture. Environmental Science & Policy 12 (5), 546-561.
- Van Ittersum, M.K., Ewert, F., Heckelei, T., Wery, J., Alkan Olsson, J., Andersen, E., Bezlepkina, I., Brouwer, F., Donatelli, M., Flichman, G., Olsson, L., Rizzoli, A.E., Van der Wal, T., Wien, J.E., Wolf, J., 2008. Integrated assessment of agricultural systems - A component-based framework for the European Union (SEAMLESS). Agricultural Systems 96 (1-3), 150-165.