



# Motivation

## Agricultural (crop) production system:

### **Complex & dynamic** system

(cultivated crops, crop rotations, management practices..)

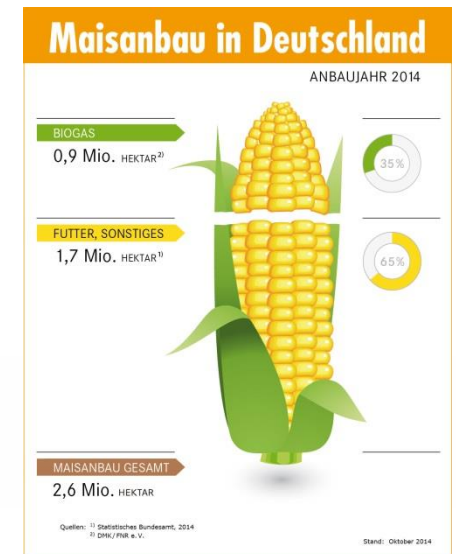
Very **high Input** (fertilizer, pesticides, management operations)

Basis for biogas & biofuel production

- Increasing **demand for agricultural products**
- Increasing **competition for (agricultural) area**
- Increasing **intensity in crop cultivation** practices

→ Definition of the agricultural systems is a key element within the set-up of a bioenergy related research study design

<b>Agricultural farms</b>	
Germany	~300.000
Central Germany	~15.000



Source: Fachagentur Nachwachsende Rohstoffe e. V. (FNR)

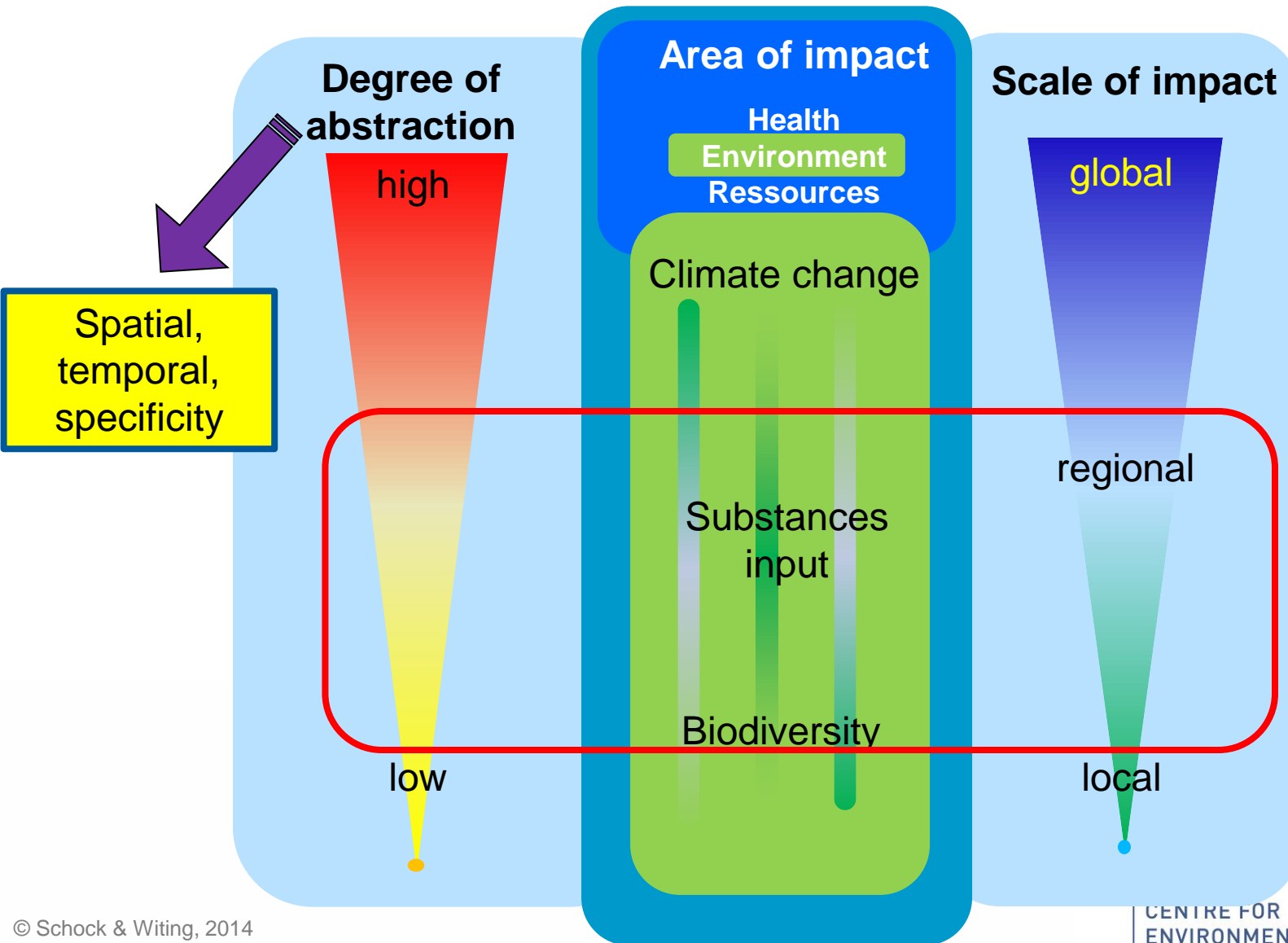


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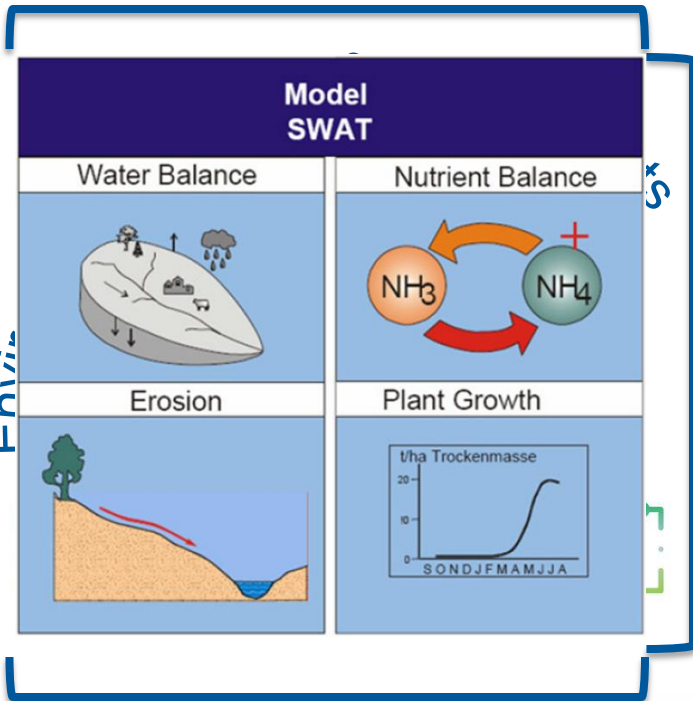
in cooperation with



# Ecological assessments: Impacts and Scales



# Regional scale assessments



## Input

- Generally lack of data
- Need for generalization

## Output

- Various & complex effects on different levels
- Need for differentiation

## Agricultural management:

- Cultivated crops
- Crop rotations
- Tillage operations
- Fertilizer application
- Management Timing (plant, harvest ..)
- ...

## Effects of agricultural management:

- Crop yield
- Nutrient run-off
- Soil organic matter
- Erosion
- Biodiversity
- Energy & GHG balance
- Farmers income
- ..

# Objective

## For regional and large scale studies:

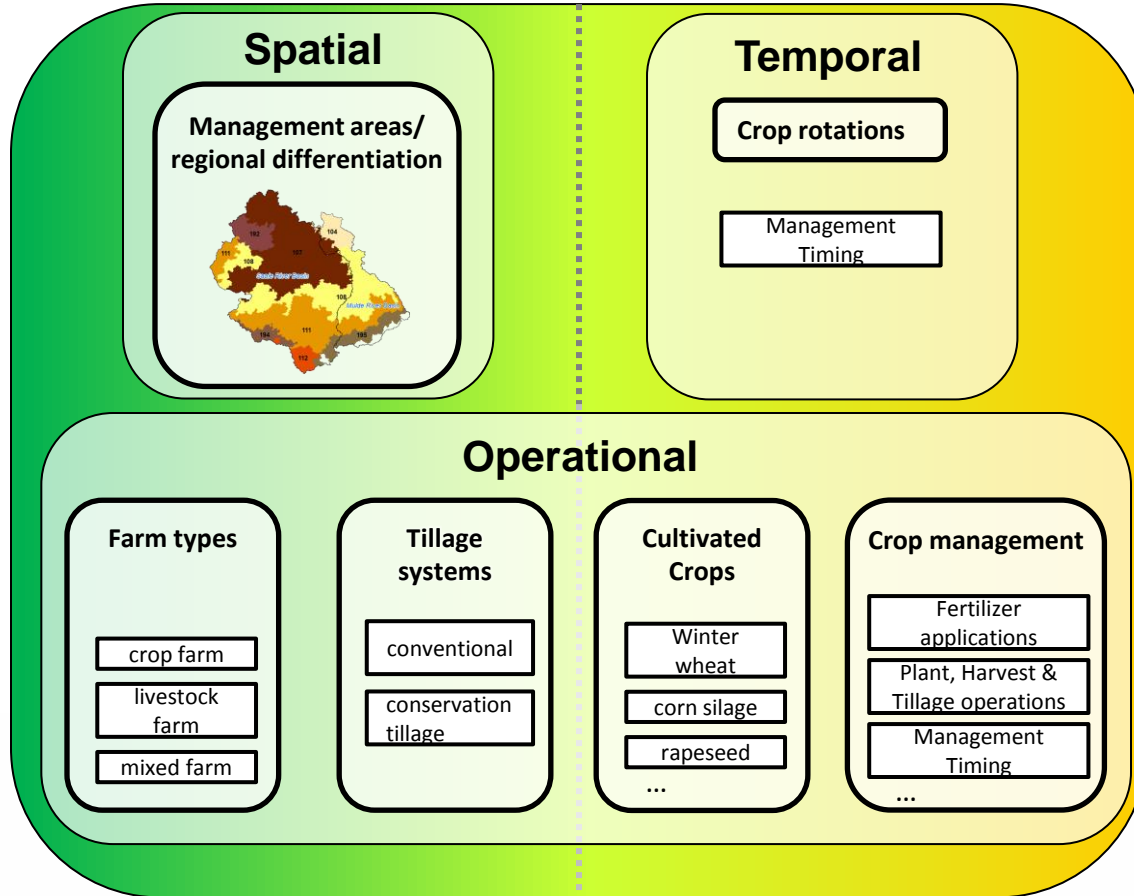
- Definition & regionalization of agricultural crop production systems
  - **Represent major quantities & mass flows of a region**
  - **Using commonly available data**
  - **Provide typical management practices and crop rotations**
  - **Using a modular design**
- Provide necessary information **as less complex as possible** and transferable to **various kinds of models & research questions**



	[%]	Average N-Demand [kg/ha]
Winter wheat	36	190
Winter rape	20	200
Winter barley	12	140
Silage maize	10	190
Spring barley	8	110
Ley grass	5	250
Winter rye	5	120
Sugar beet	4	170

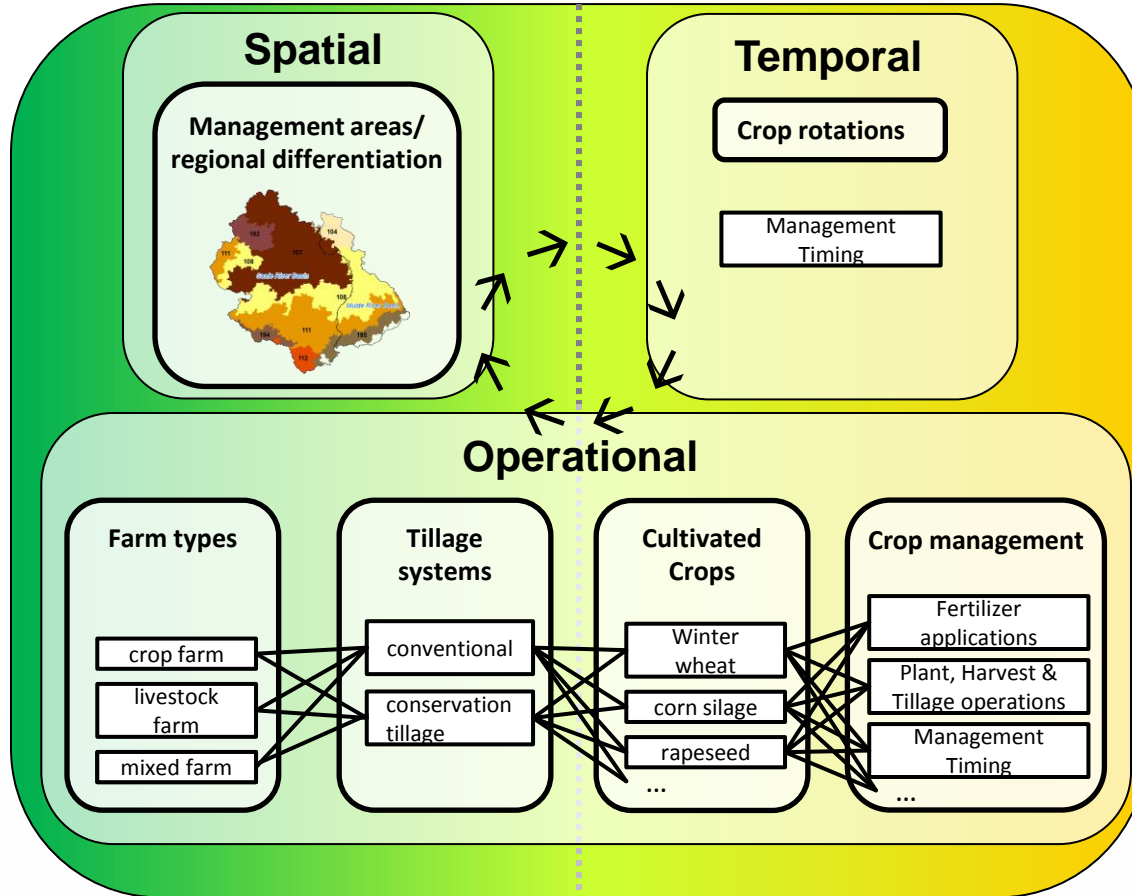
# Levels of differentiation

## Levels of differentiation:



# Levels of differentiation

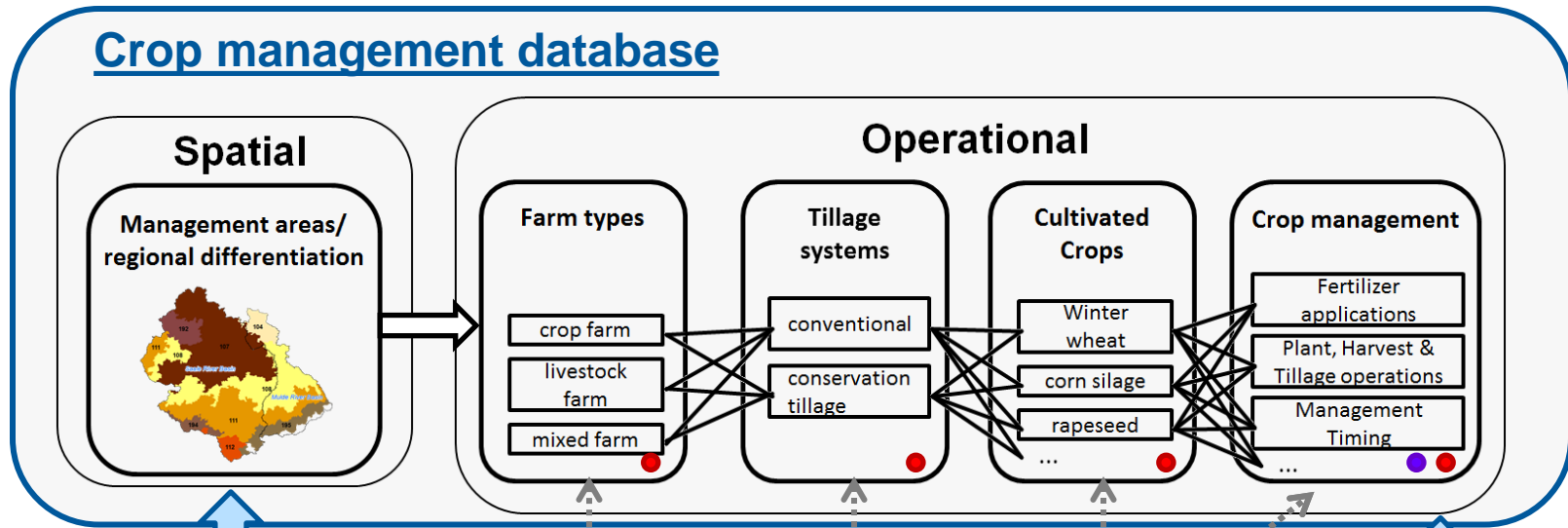
## Levels of differentiation:



- Definition of relationships, properties & boundaries

# Workflow & database-setup

## Crop management database



Data, quantities & mass flows on regional level

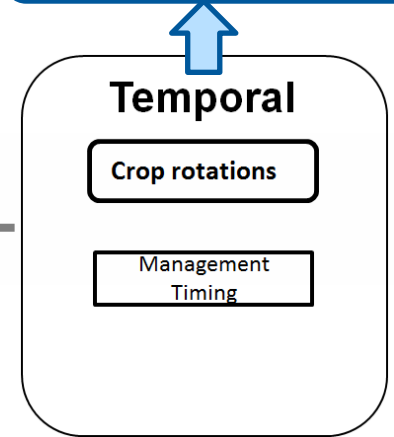


- Regionally differentiated statistics (commonly available)
- Expert knowledge, statistics of fertilizer consulting software, official recommendations & regulations,

Break-down of data over various levels of differentiation



Combination according to the individual needs of your assessment

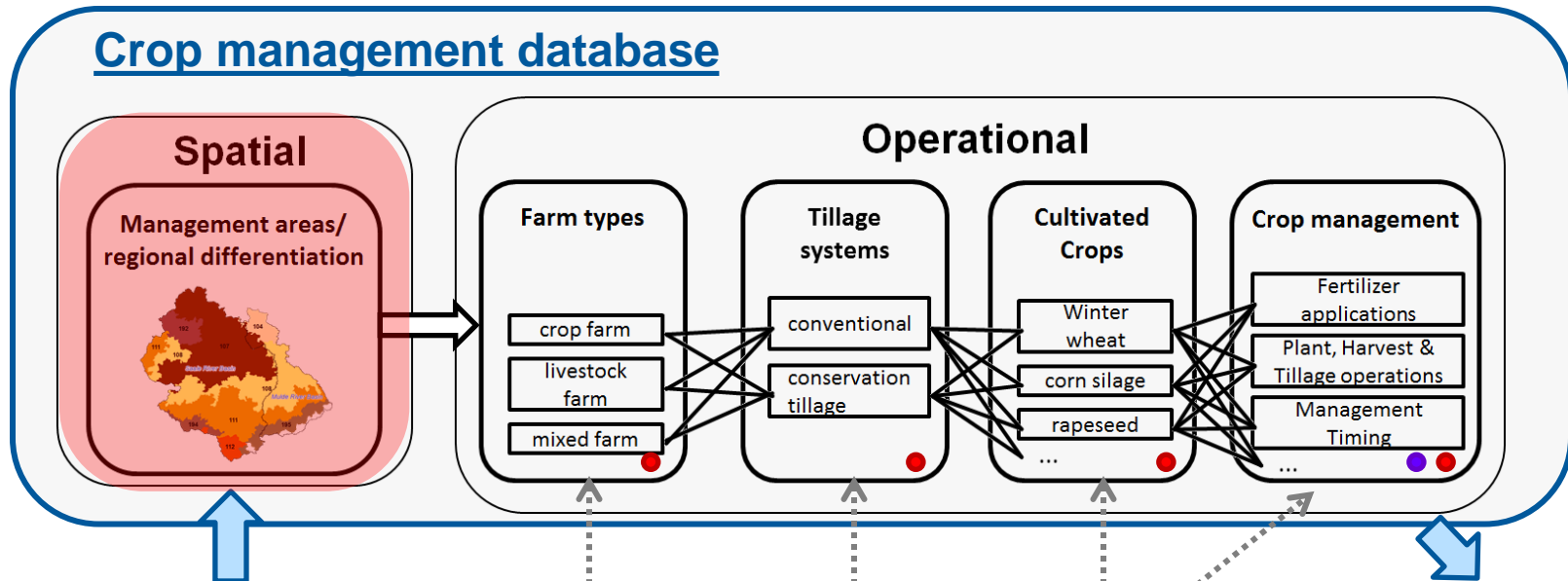


Picture-source (from left to right):  
Thomas Max Müller / pixelio.de; Wilhelmine Wulff / pixelio.de



# Workflow & database-setup

## Crop management database



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Temporal

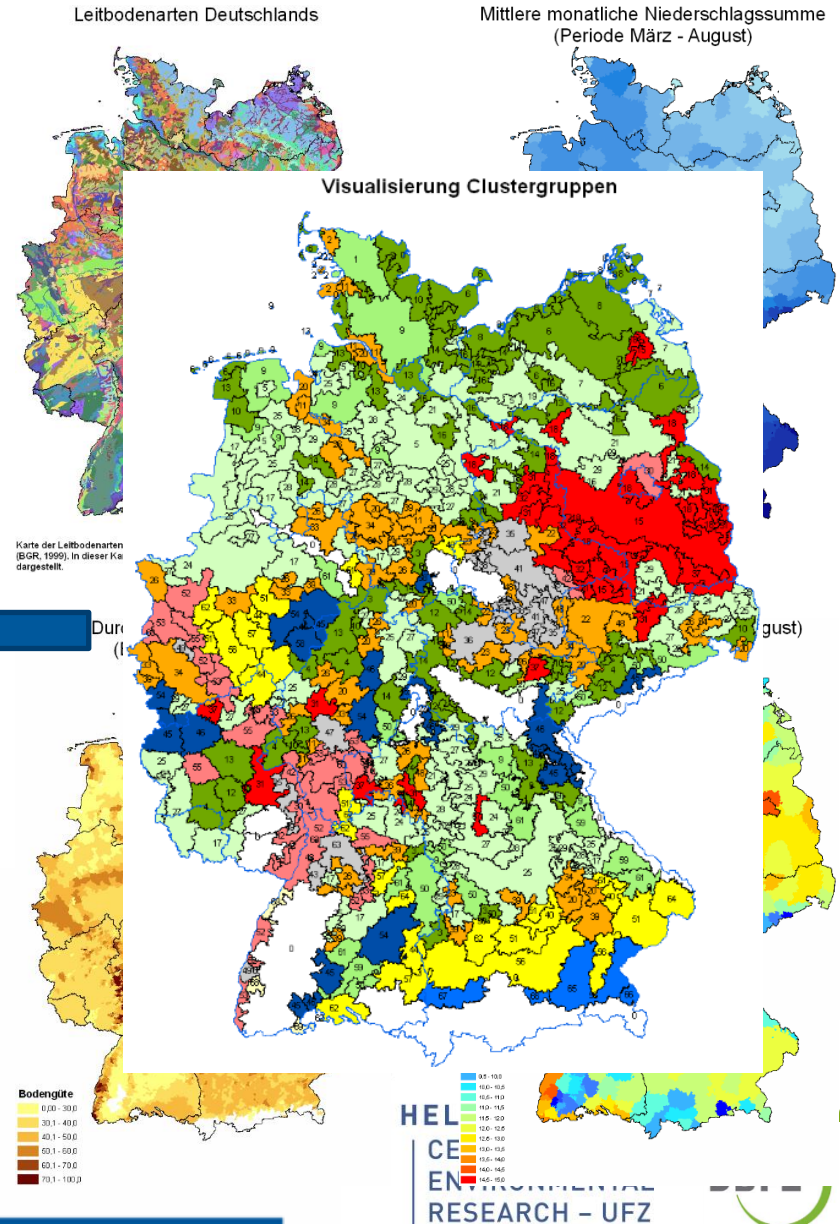
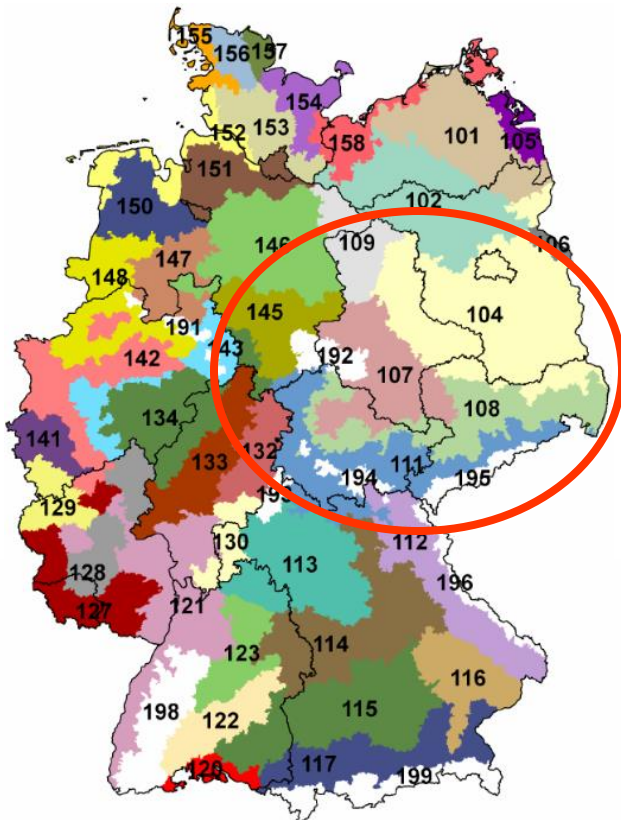
Crop rotations

Management Timing

# Regional differentiation

## Soil-Climate-Regions

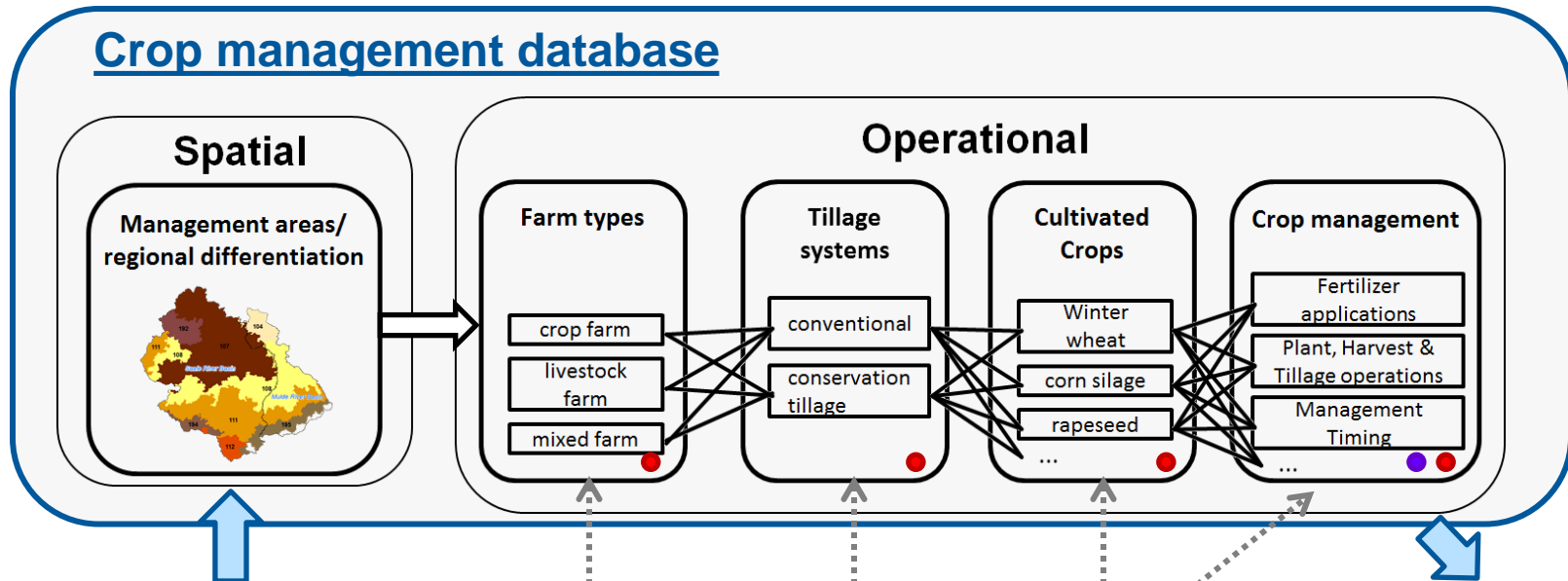
Designed for comparison of agricultural research (esp. crop growth studies)



Source: ROSSBERG, D., V. MICHEL, R. GRAF, R. NEUKAMPF, 2007: Definition von Boden-Klima-Räumen für die Bundesrepublik Deutschland. Nachrichtenblatt des Deutschen Pflanzenschutzdienstes 59 (7), 155-161.

# Workflow & database-setup

## Crop management database



Data, quantities & mass flows on regional level

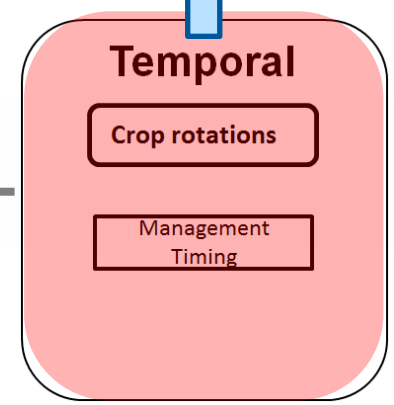


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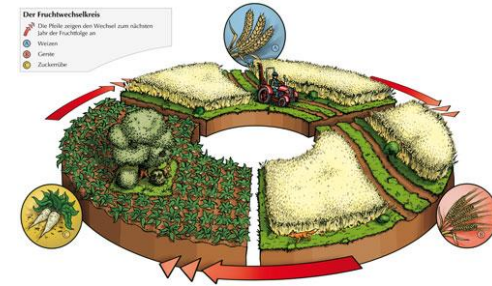


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# Selection of crop rotations

## Crop rotations in Germany:

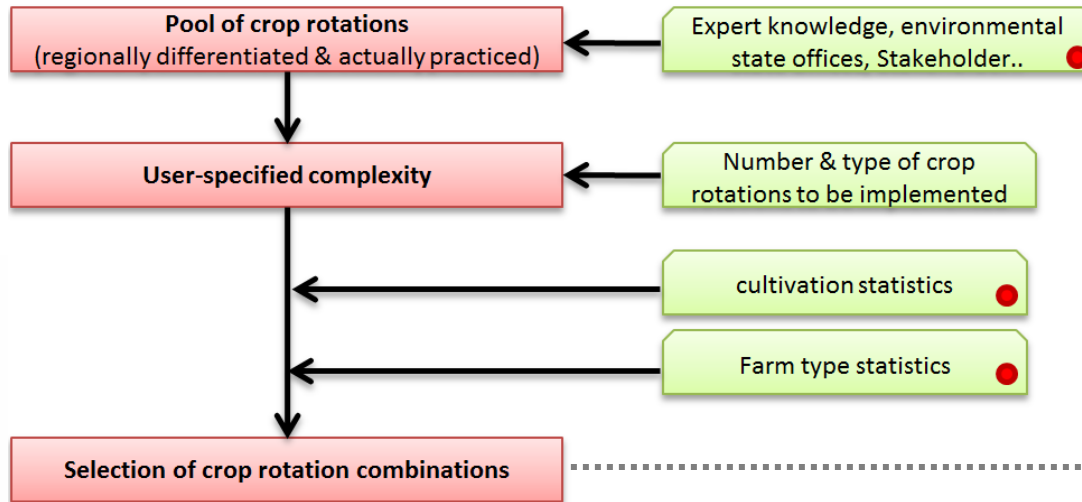
- From 2-crops crop-rotations up to very complex combinations
- More and more market driven, less “typical” crop rotations



## How do we choose suitable crop rotations?

Objective: realistic, but as less complex as possible

Method: Selection out of a pool of rotations actually in practice



	Desired number of crop rotations
Cash-crop farm	2
Livestock farm	1
Mixed farm	1

	[%]
Winter wheat	36.2
Winter rapeseed	20.4
Winter barley	12.5
Silage maize	9.6
Spring barley	7.6
Ley grass	4.9
Winter rye	4.9
Sugar beet	3.9

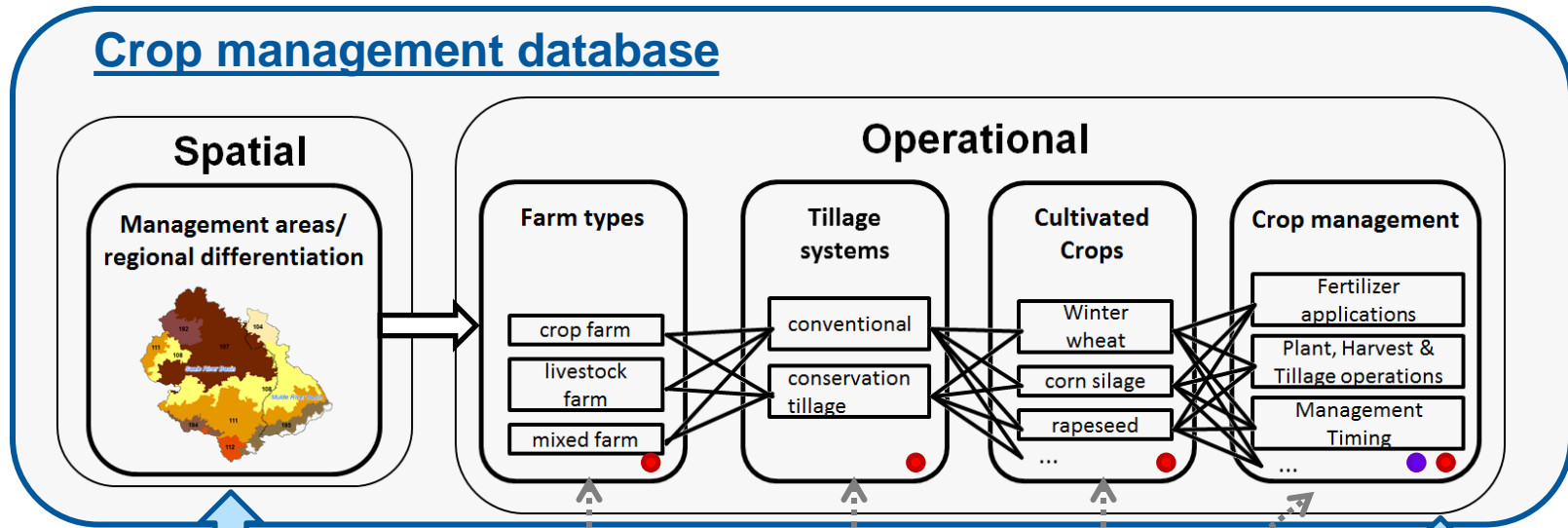
	[%]
Cash-crop farms	69.7
Livestock farms	7.6
Mixed farms	22.7

[1,] Winter rapeseed	[1,] Silage maize
[2,] Winter wheat	[2,] Winter wheat
[3,] Winter wheat	[3,] Winter barley
[1,] Sugar beet	[1,] Winter wheat
[2,] Winter wheat	[2,] Ley grass
[3,] Spring barley	[3,] Winter rapeseed
[4,] Winter rapeseed	[4,] Winter wheat
[5,] Winter rye	[5,] Winter barley
	[6,] Winter rapeseed

● = Regionally differentiated data; on the level of management areas

# Workflow & database-setup

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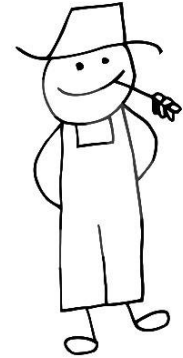
Temporal

Crop rotations

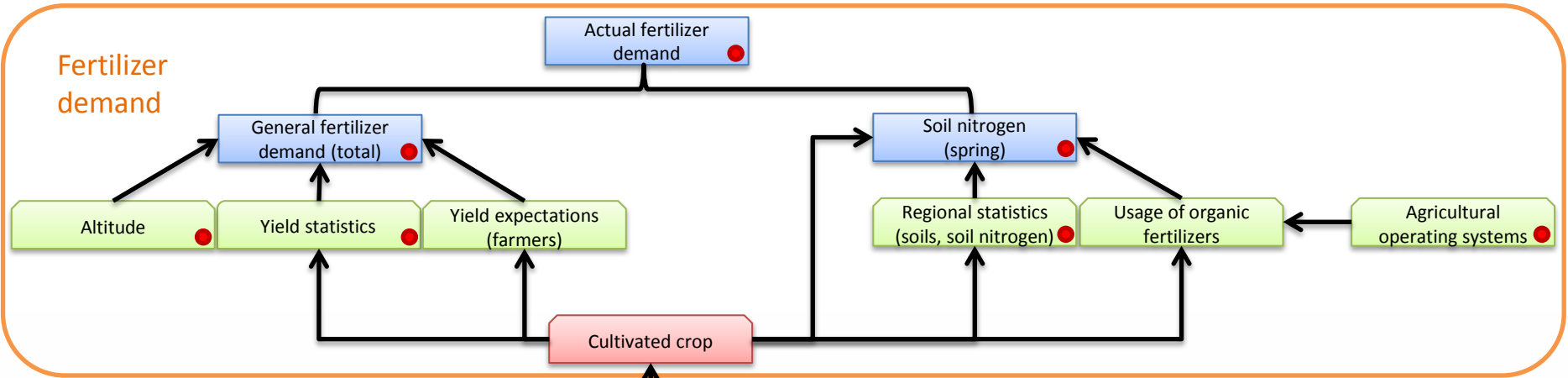
Management Timing

# Example: Nitrogen fertilizer on regional level

- Based on models for the determination of fertilizer requirements:
  - Official recommendations & guidelines of state agencies
  - Available to farmers and widely applied



Fertilizer demand

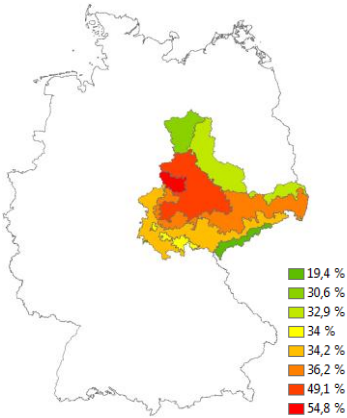


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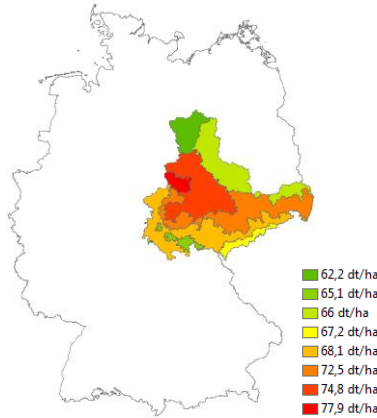
- Winter wheat
- (Silage) Maize
- Winter rape
- Sugar beet
- Winter barley
- Spring barley
- Winter rye
- Agricultural grass

# Example: Nitrogen fertilizer on regional level

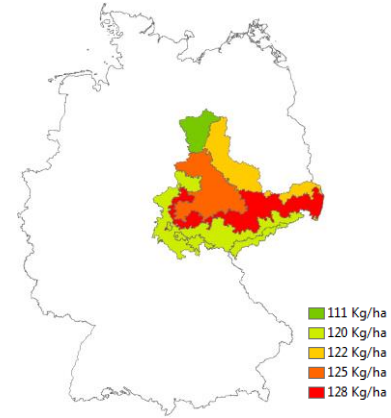
Cultivation statistic: winter wheat



Yield statistic: winter wheat



Average actual fertilizer demand: winter wheat



## Fertilizer demand

Actual fertilizer demand

General fertilizer demand (total)

Soil nitrogen (spring)

Altitude

Yield statistics

Yield expectations (farmers)

Regional statistics (soils, soil nitrogen)

Usage of organic fertilizers

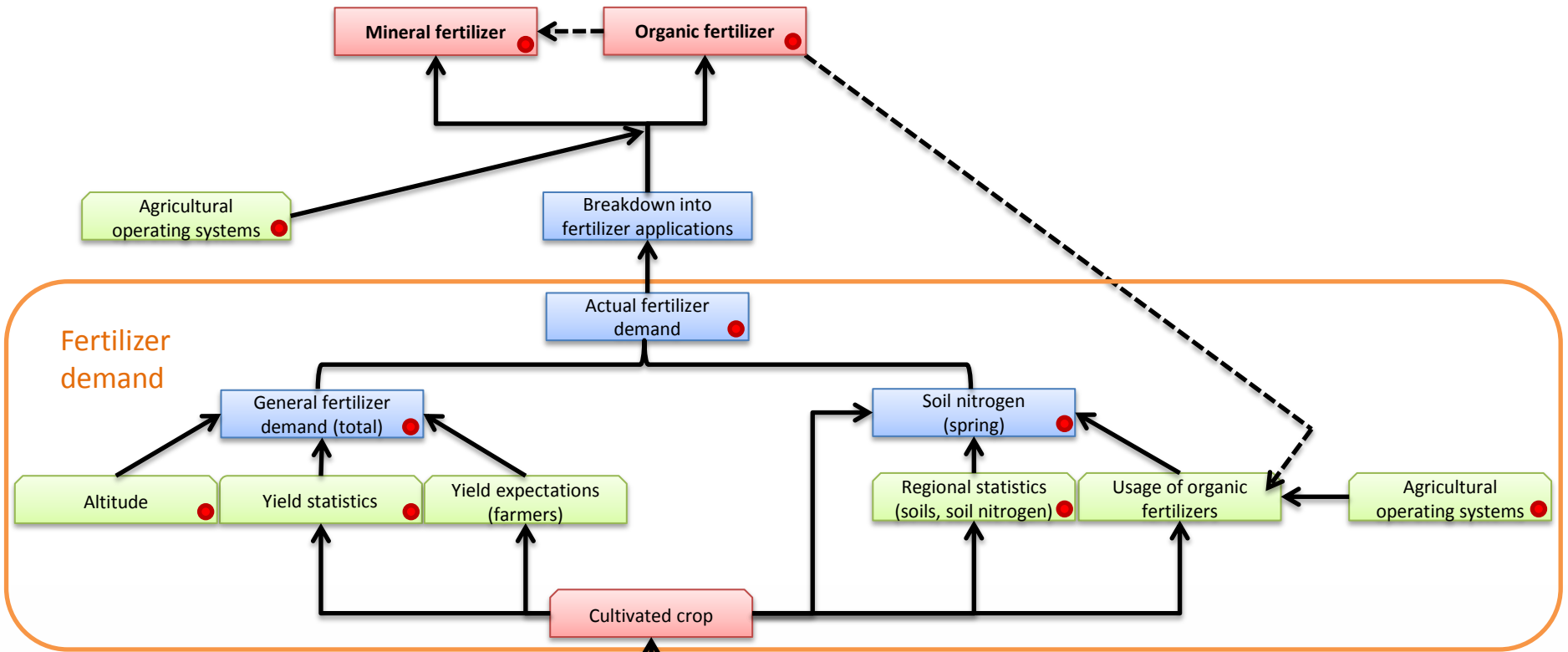
Agricultural operating systems

Cultivated crop

● = Regionally differentiated data; on the level of management areas

- Winter wheat
- (Silage) Maize
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- Sugar beet
- Winter barley
- Spring barley
- Winter rye
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# Example: Nitrogen fertilizer on regional level

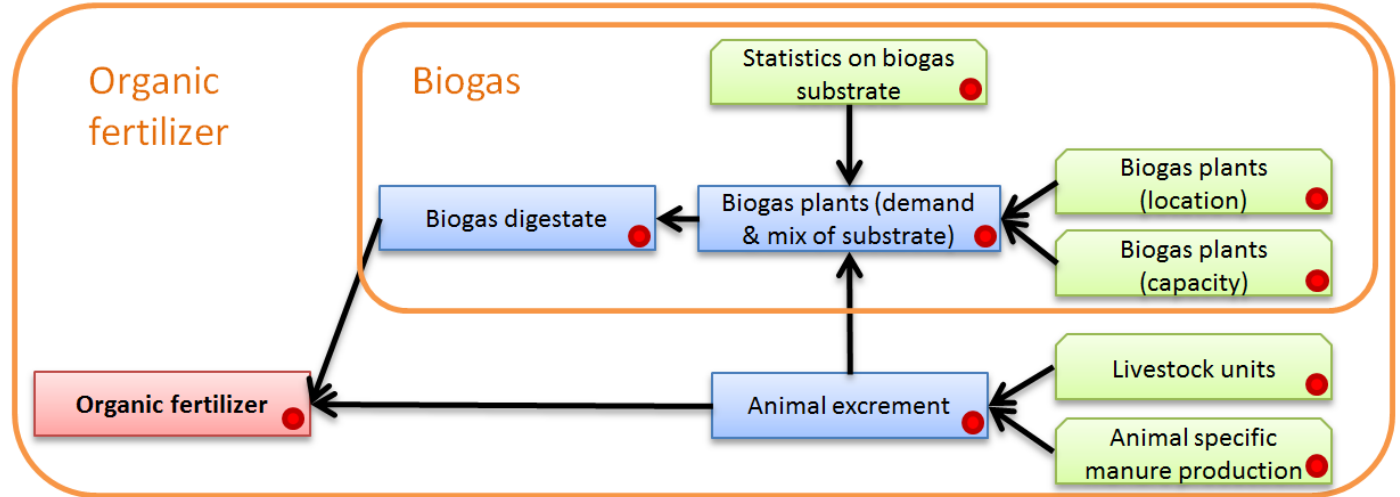


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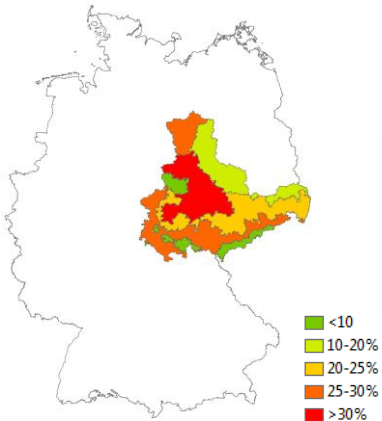
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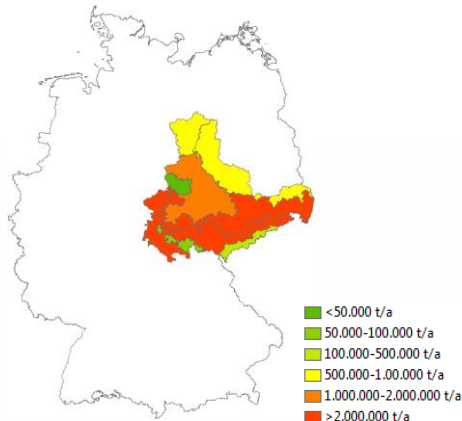
# Example: Nitrogen fertilizer on regional level



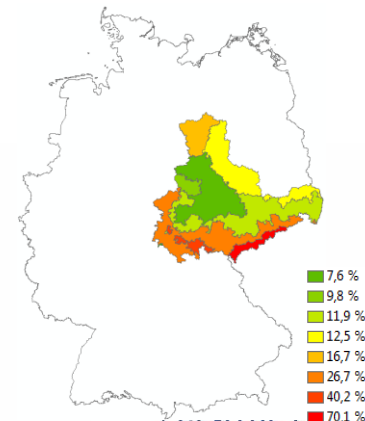
Share of excrement that is used for biogas



Biogas digestate available



Farm type statistic: livestock farms

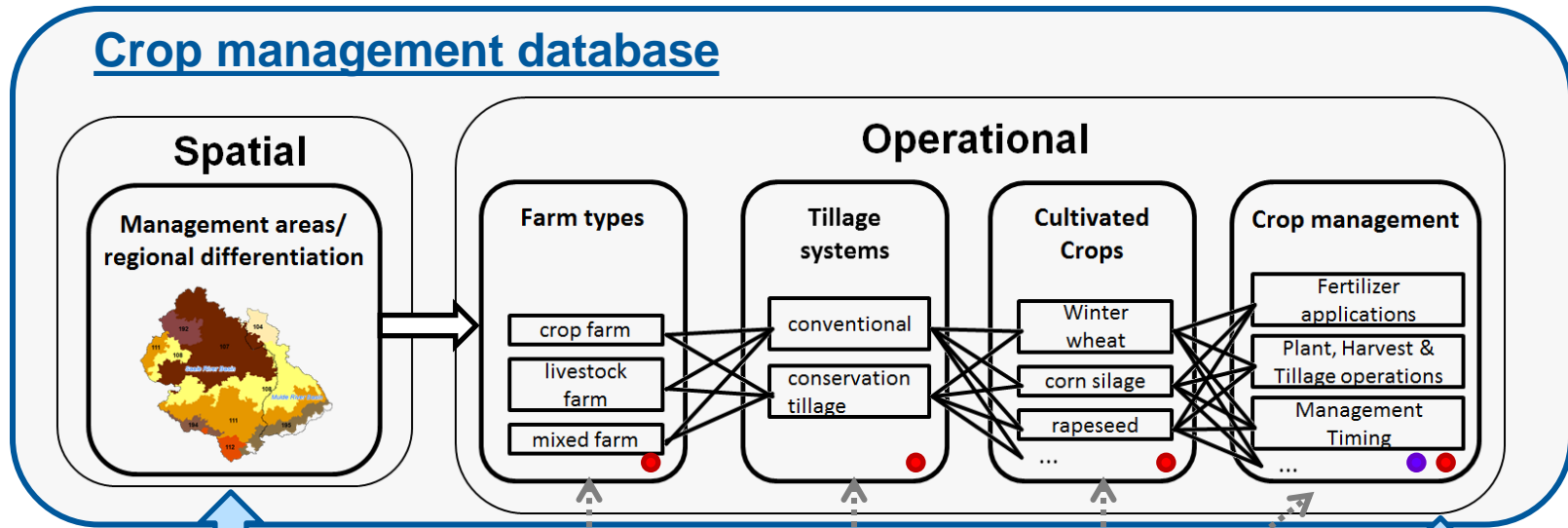


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in cooperation with **DBFZ**

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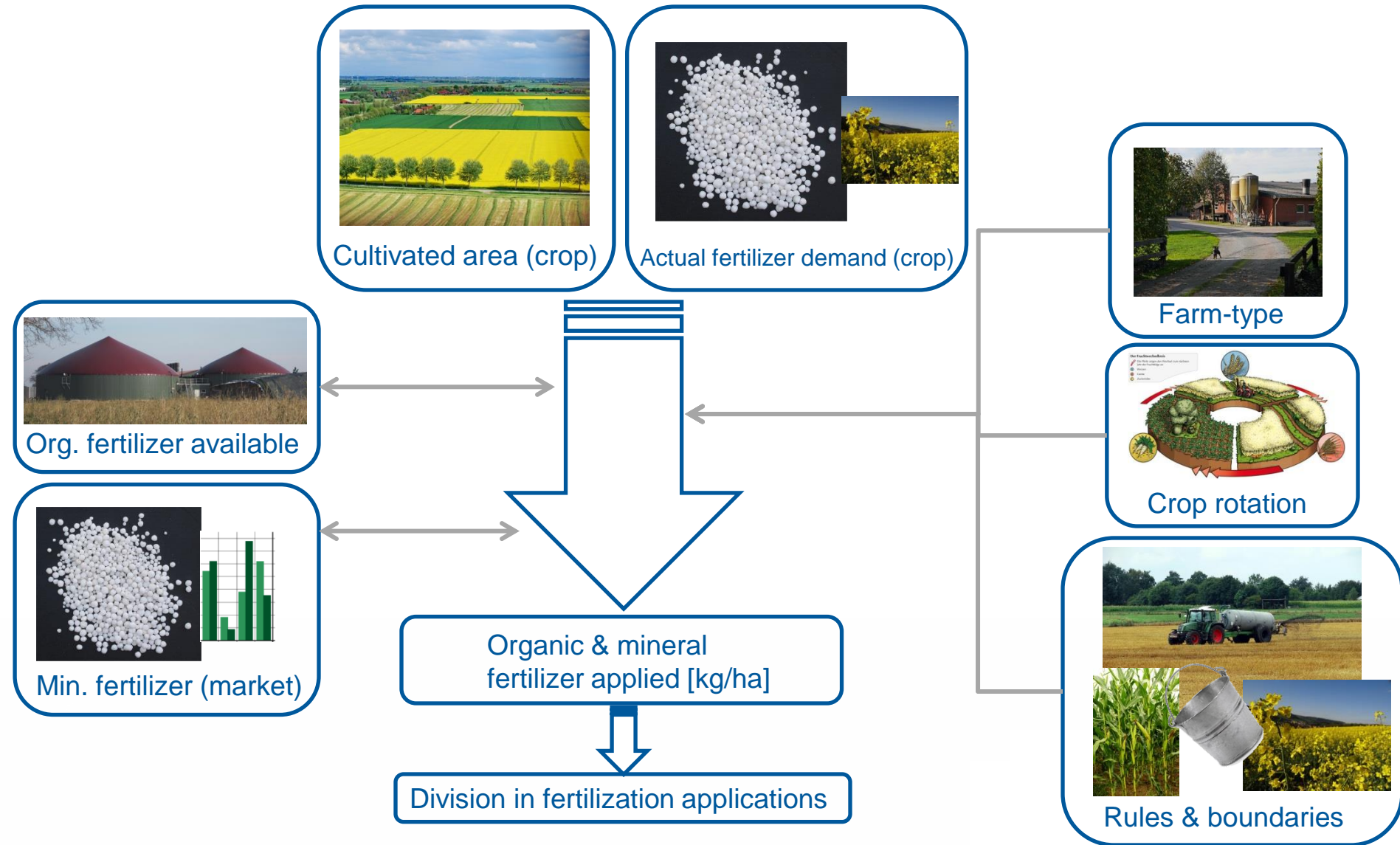
Temporal

Crop rotations

Management Timing

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# Example: Nitrogen fertilizer on regional level



# Conclusion

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- Framework for the definition and regionalization of agricultural crop production systems on regional and large scales
- Differentiation design covers many relevant management options:
  - Crop rotations
  - Cultivated crops
  - Tillage operations
  - Organic & mineral fertilization
  - Management timing
  - ...

## Benefits:

- Flexibility in scenario design
- Consideration of regional balances & mass flows
- Provision of detailed management plans for different crops and cropping systems
- Allows analysis within the database itself
- Transferable to many kinds of models & assessments, due to modular design
- Valuable framework for numerous land-use & land-management studies (not only bioenergy cropping)



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# Thank you!!

