

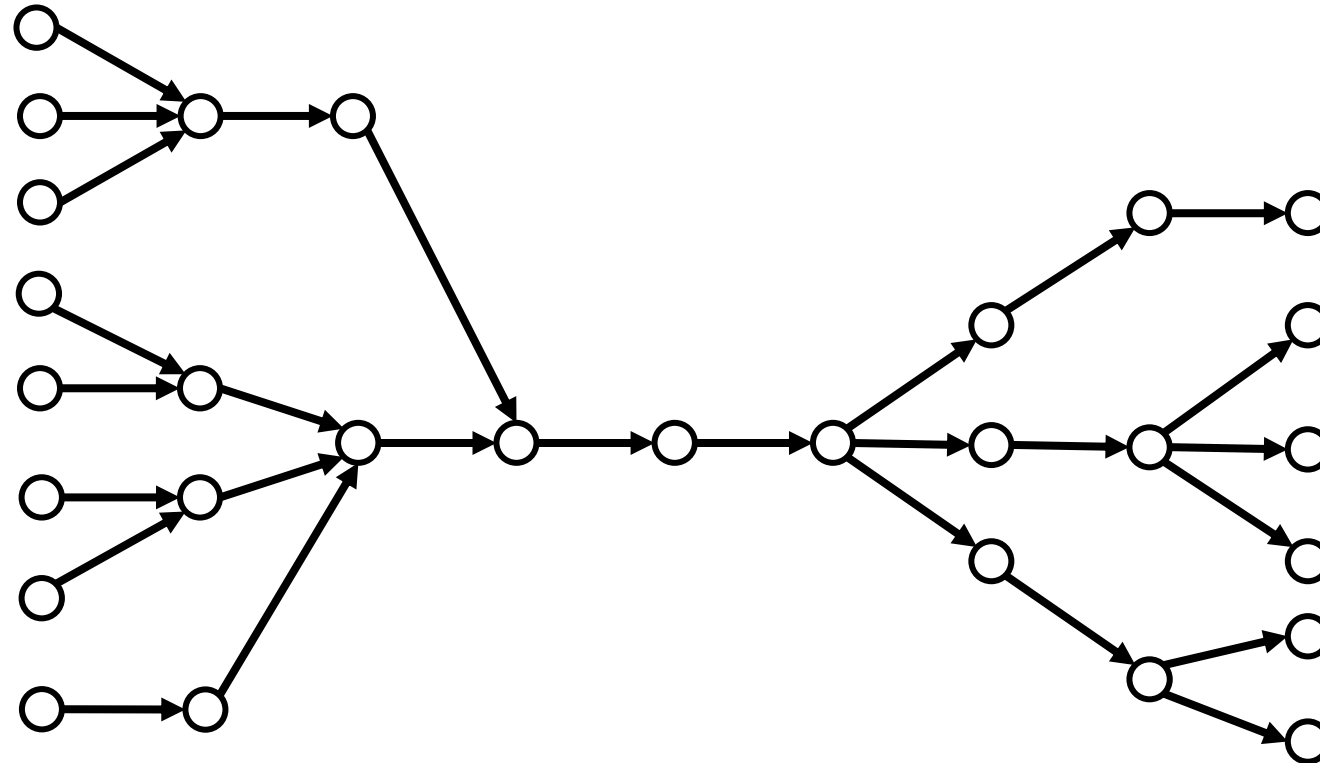
# Numeric Formulation of the Biodiversity Value of Ecosystems as a Function of Anthropogenic Use Intensity in Life Cycle Assessment

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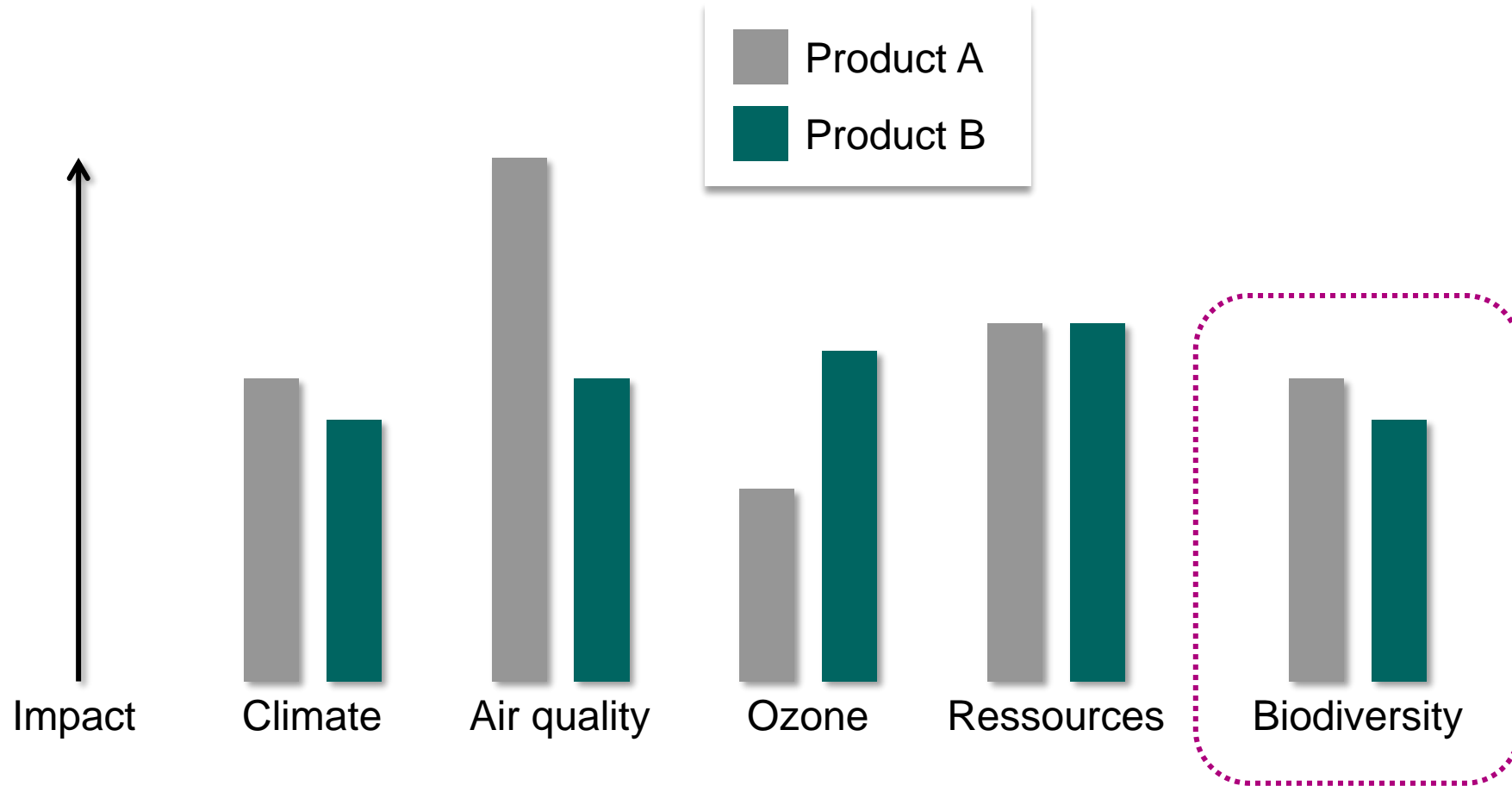
# Methodological context

## Life Cycle Assessment



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# Methodological context

## Life Cycle Assessment

- Impact = inventory quantity × characterization factor

\_\_\_ kg CO<sub>2</sub>

Factor 1

\_\_\_ kg CH<sub>4</sub>

Factor 28

\_\_\_ kg N<sub>2</sub>O

Factor 265

Climate impact

\_\_\_ m<sup>2</sup>a almond plantation

Factor \_\_\_

\_\_\_ m<sup>2</sup>a wheat field

Factor \_\_\_

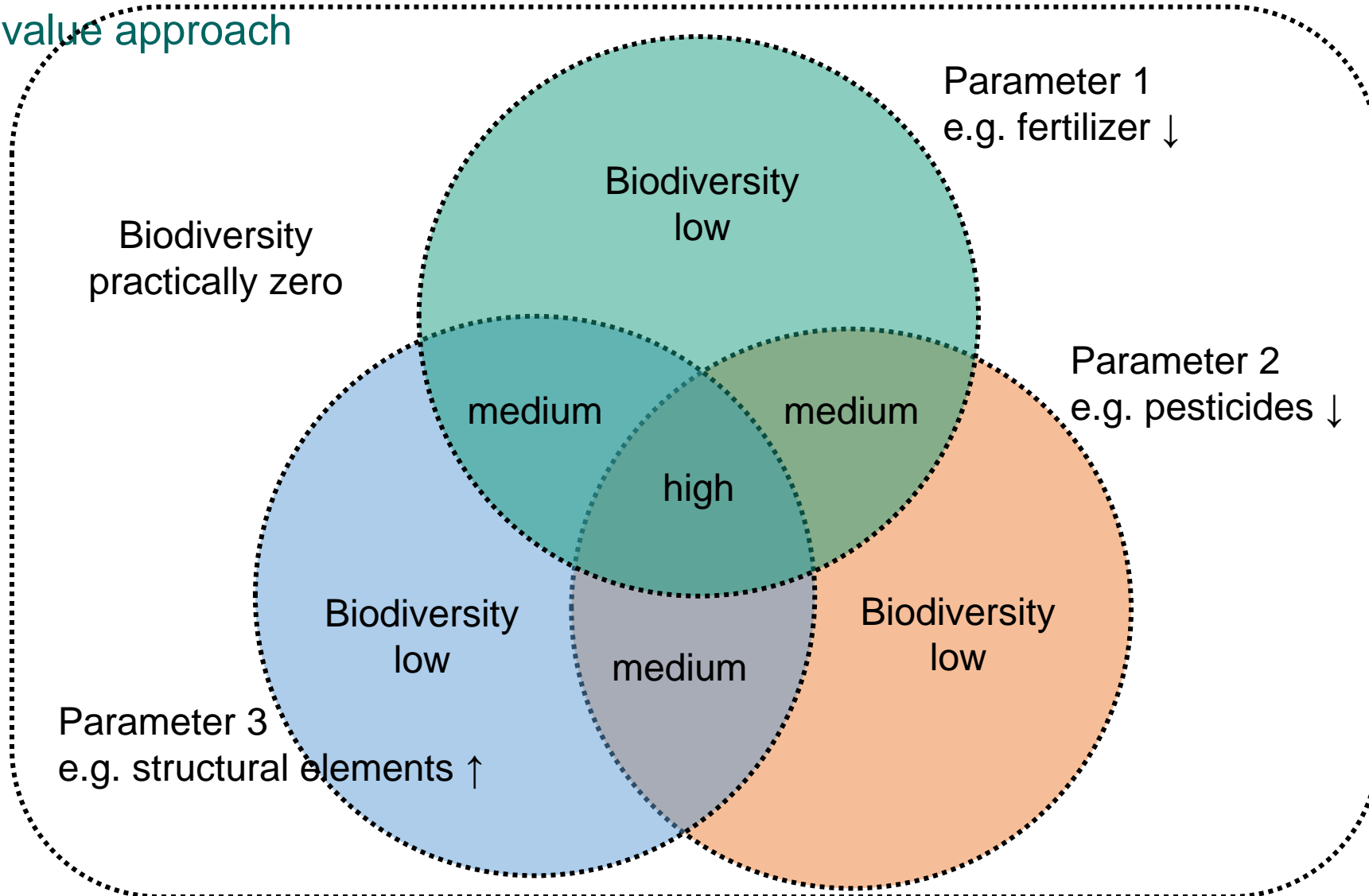
\_\_\_ m<sup>2</sup>a spruce forest

Factor \_\_\_

Biodiversity impact

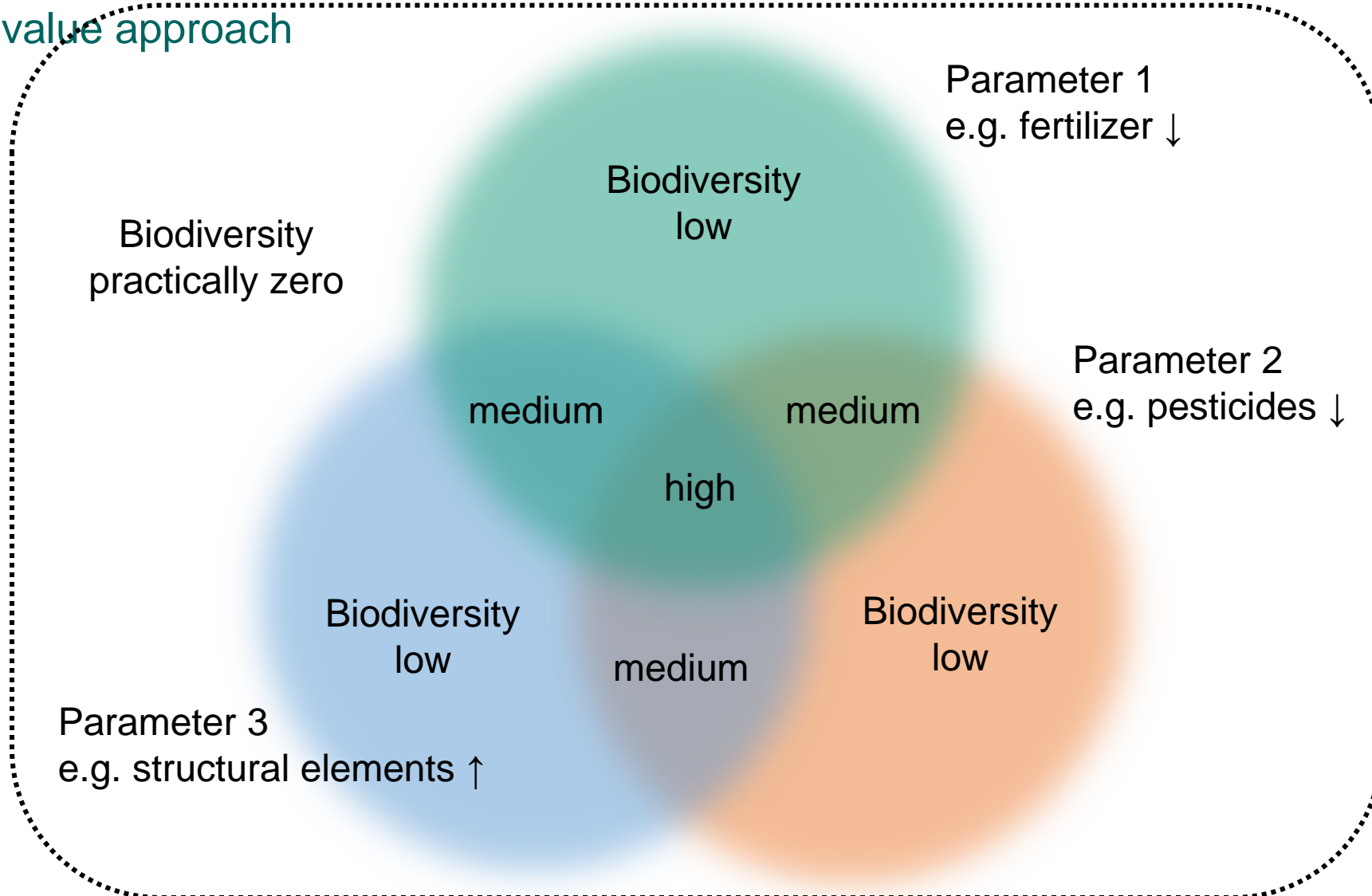
# Methodological context

## Biodiversity value approach



# Methodological context

## Biodiversity value approach



# Hemeroby as the basis

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- Greek: *hémeros* (tamed, cultivated) / *bíos* (living)  
→ Measure of the degree of cultivation of ecosystems and landscapes
- Origin: Description of the disturbance of ecosystems (Jalas 1955)
- Concept of hemeroby classes (Blume & Sukopp 1976): Aim to investigate and classify different forms of land use according to the **degree of cultural influence on ecosystems by selected criteria**  
→ seven-classes from *ahermob* (**close to nature**) to *metahemerob* (**distant from nature**)
- the concept was further developed, among other things, to be able to use it in life cycle assessments (Fehrenbach et al. 2015/2019/2021)

# Hemeroby as the basis

## Land use types within the hemeroby concept

The hemeroby class system with indicative allocations of the distribution of different land use types

Hemeroby class	Forest/Forestry	Agriculture	Settlement areas		
I natural	Primary forest, no use				
II	More				
III	to	Grassland, extensive, species-rich to intensive management	Arable land, extensive to intensive management	Derelict land	Mining areas
IV	less natural forest management				
V					
VI	Timber plantations				
VII					Sealed surface

Dashed borders show extreme cases, both positive (raw material extraction areas with high nature value potential) and negative (timber plantations with permanent damage to the self-regulating capacity of ecosystems such as eucalyptus plantations).

Reference: own representation 2021, ifeu, extended from (Fehrenbach et al. 2015)

Fehrenbach et al. (2021)



# Hemeroby as the basis

## How to determine the hemeroby class of a given land use?

→ criteria catalogue for several land use types, e.g.

- forestry
- agriculture
- mining
- grassland
- settlement areas
- marine areas (under development)

Criteria and metrics of the arable land evaluation system

Criterion	Metric (updated)	Application and values (1 to 5)
1. Diversity of the arable flora	1. Number of segetal species	Number of segetal species per 100 m <sup>2</sup> : >40   36-40   26-39   10-25   <10
	2. Existence of rare species	Number of red list species per 100 m <sup>2</sup> : (rounded) >3   1-3   0,5-0,9   >0-<0,5   0
2. Structural diversity	3. Structural elements in the landscape	Percentage of selected ecological priority areas out of total agricultural land: >3%   1-3%   1-1,9%   >0->1%   0%
	4. Field size	Mean field size per crop: <1 ha   1-<3 ha   3-<6 ha   6-<9 ha   >9 ha
	5. Diversity in the landscape	Classified Shannon Evenness Index (SEI) of national agriculture: 5   4   3   2   1
3. Soil protection	6a. Intensity of soil disturbance	Descriptive design of the tiers (e.g. "Conservation tillage (without ploughing) without loosening, no heavy machinery" for tier 2.
	6b. Soil compaction due to agricultural machinery use	Diesel consumption from use of agricultural machinery (in L per ha): <30   30-<50   50-<70   70-<90   >90
	7. Soil cover (cover and land management factor)	Derived from C-factor (cover and land management factor) <0,05   0,05-0,1   >0,1-0,2   >0,2-0,3   >0,3
	8. Agricultural diversity	Area percentage of field crop of total area in the region: <2%   2-<5%   5-<10%   10-<20%   >20%
4. Material inputs	9. Type of fertilisation	Descriptive design of the tiers (e.g. "Fertilisation only by in-house means (farm manure: exclusively solid), no external input" for tier 1
	10. Intensity of fertilisation	Input of nitrogen fertiliser from mineral fertiliser or farmyard manure (in kg N per ha): 0   >0-<50   50-<75   75-<100   >100
	11a. Use of insecticides	Descriptive design of the tiers (e.g. "exclusively biological, biotechnical and physical measures" for tier 2).
	11b. Plant protections measures (excl. insecticides)	Application of plant protection agents and fortifiers, in treatment index (TI): TI=0, preventive measures   TI=0, biological measures   >0-<2   2-<4   >4

Fehrenbach et al. (2021)

# Hemeroby as the basis

In which value level (1-5) of the metric field size is a land use classified?

## Example maize:

- Data: remote sensing data from OneSoil (2019)



ESA (2019)



OneSoil (2019)

Mean field size per crop:	
1.	< 1 ha
2.	1 – < 3 ha
3.	3 – < 6 ha
4.	6 – < 9 ha
5.	> 9 ha

- Average field size of maize in Germany: 7.25 ha → Value level 4 → **4 points**

# Hemeroby as the basis

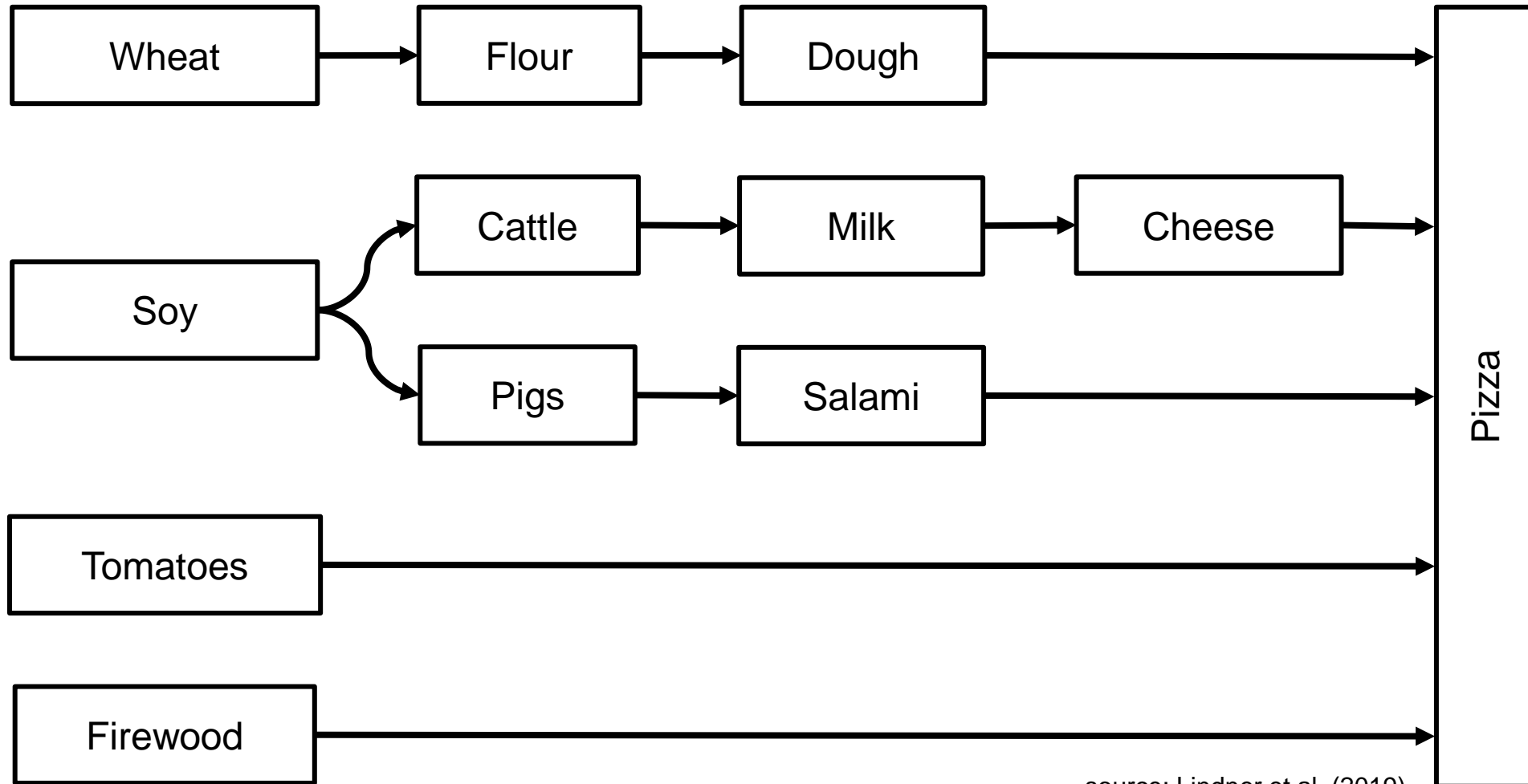
## How to come from point values to hemeroby classes?

- Point values are assigned for alle metrics
- Aggregation through fuzzy operators + linear aggregation
- **Assignment of the end value to hemeroby classes II – VII**
  - E.g. German average maize
    - hemeroby class IV (based on generic data)
    - hemeroby class ? (based on specific data, measured in the field)

Summarized: The hemeroby concept can be used to evaluate land use in terms of its intensity of use and thus to express the quality of the land in quantitative terms.

# Example

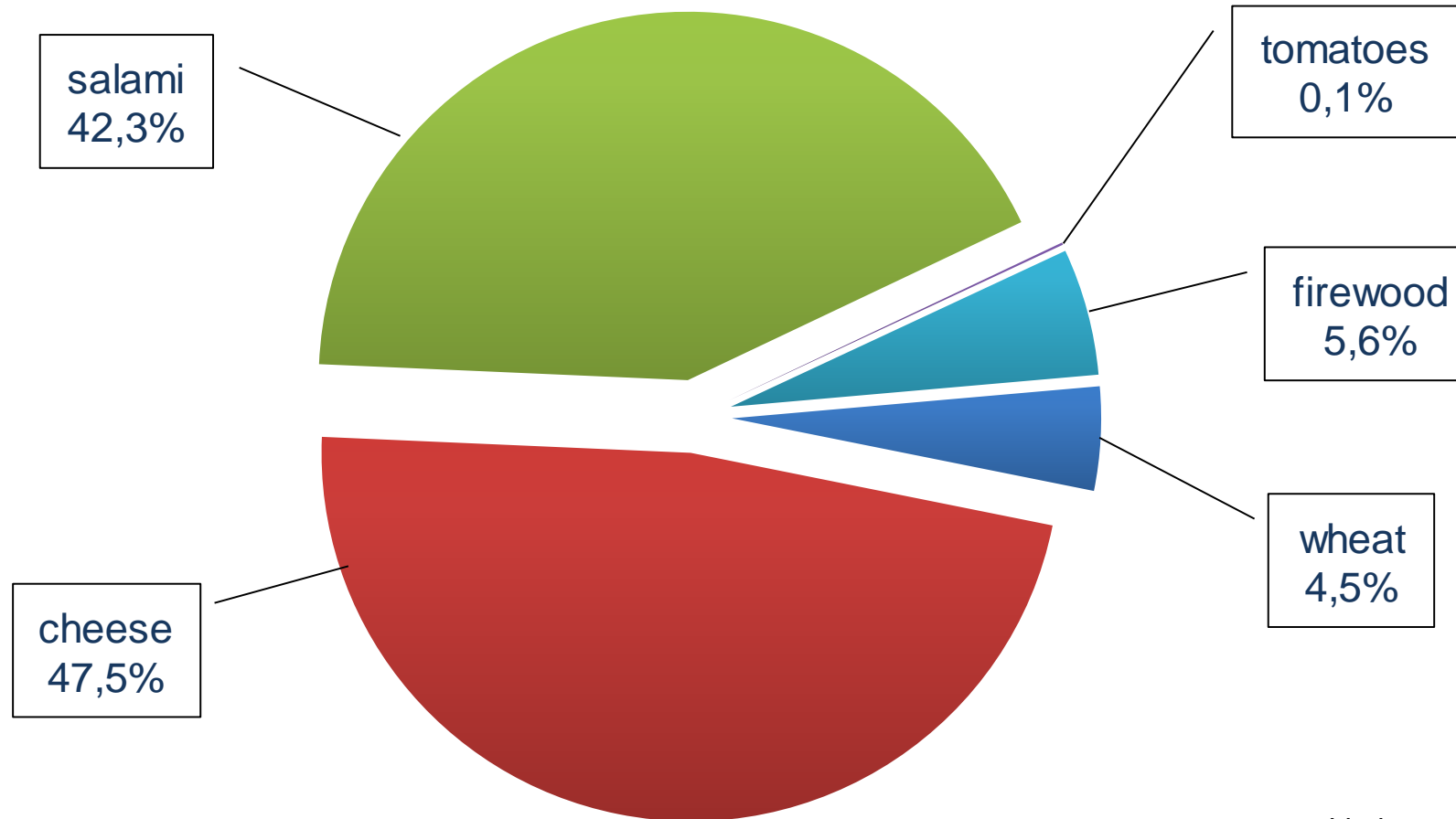
## Pizza with cheese and salami, baked in wood-fired oven



source: Lindner et al. (2019)

# Example

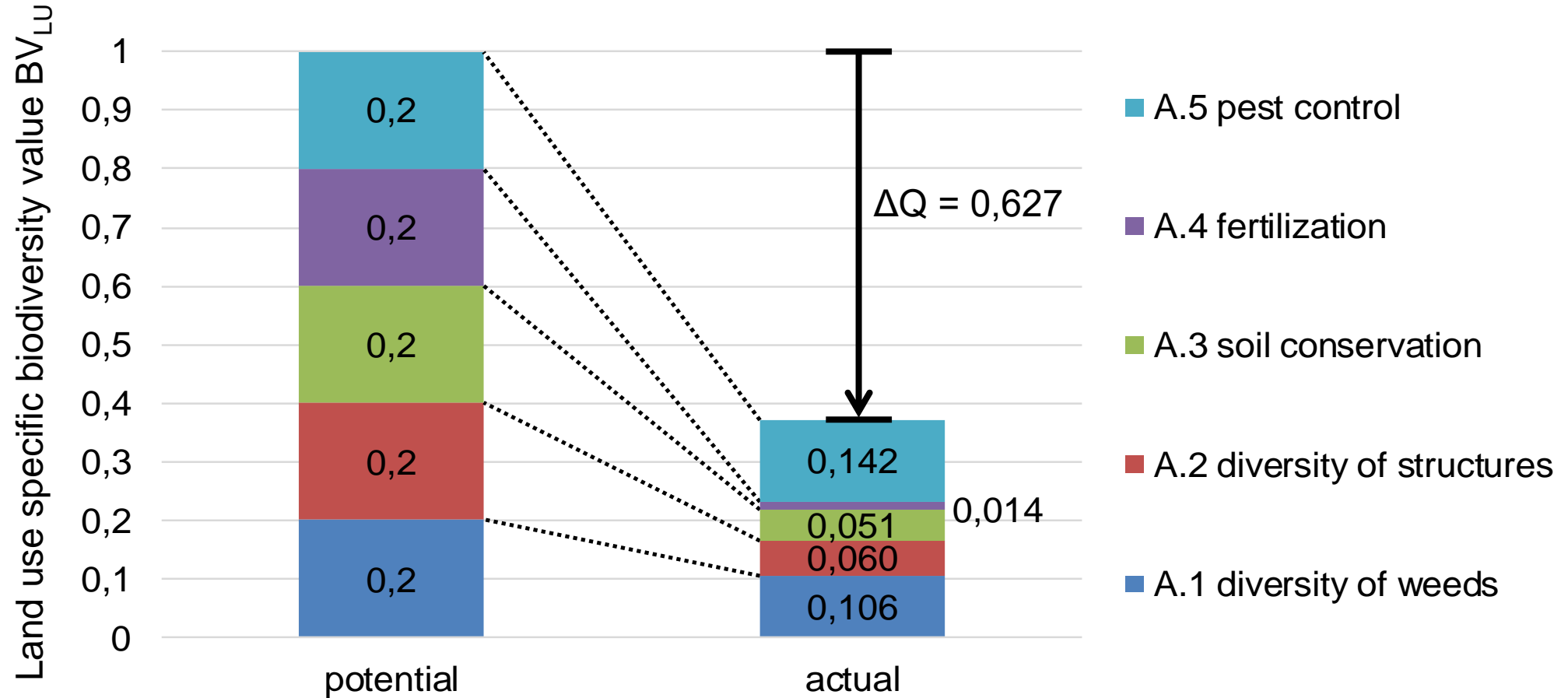
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source: Lindner et al. (2019)

# Example

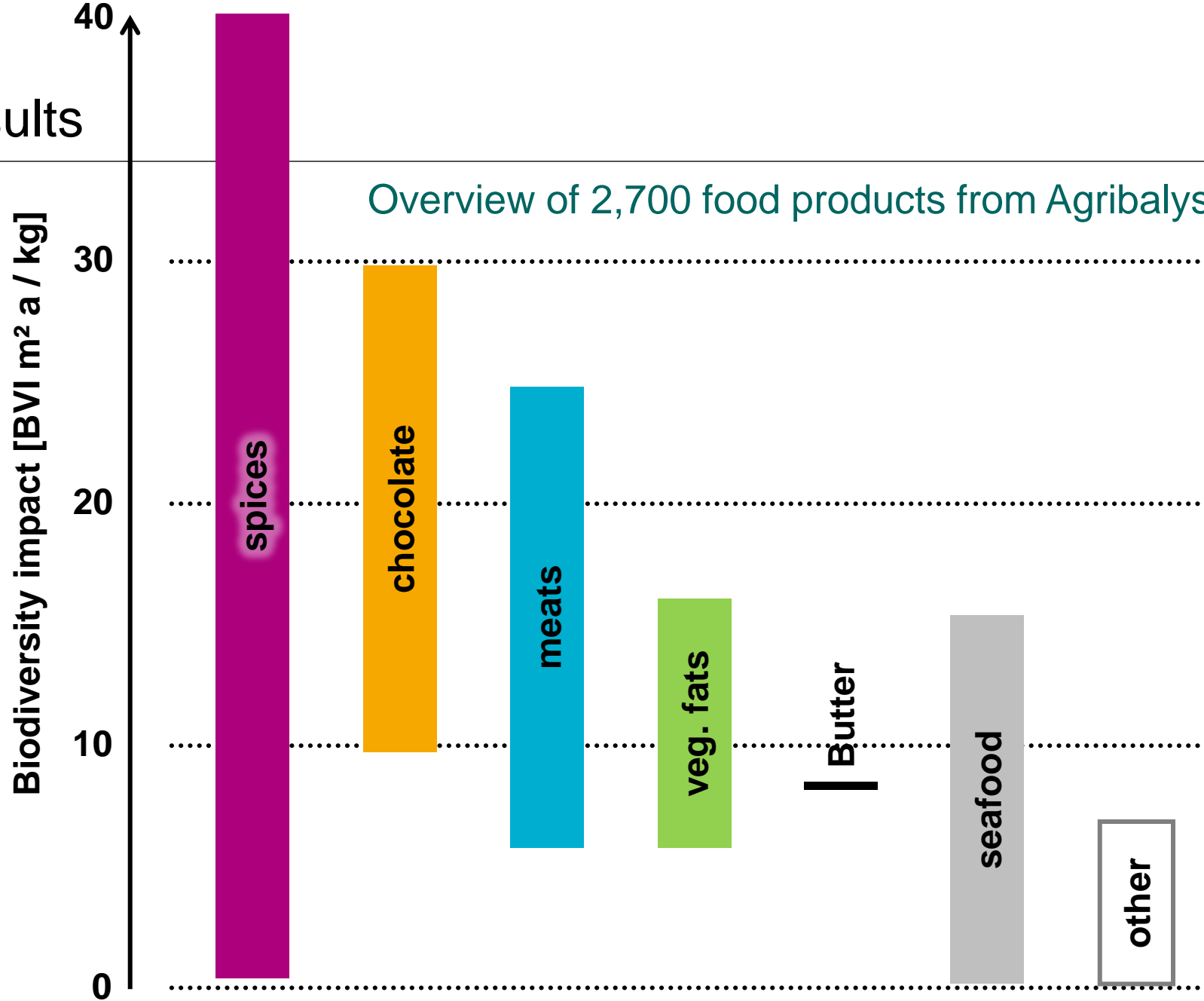
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source: Lindner et al. (2019)

# Example results

Overview of 2,700 food products from Agribalyse database





Thank you for your attention!

Any questions?



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