APPLIED PLANT RESEARCH

Design of Farming Systems

IAC course

Transition to sustainable agriculture

W. Sukkel, 30-05-2005

Personal introduction

- Wijnand Sukkel
- Agronomist, Specialist organic plant production

Applied Plant Research (PPO)
Wageningen University and Research Centre (WUR),

Content

- Background
- System innovation
- Prototyping
- Farming methods
- Some results and experiences

(Dutch) agricultural problems

Agronomical

- soilfertility and soilhealth
- control of pests diseases and weeds
- high quality demands

Economical

- lower prices, basic income under pressure
- availability and costs of labour

(Dutch) agricultural problems

Environmental/ecological

- pollution of air water and soil with nutriënts and pesticides
- decline of nature and landscape

Society

- concern for food safety
- claim for multifunctional land use

Conflicts

ecology ⟷ economy

diversity ⟷ homogeneity

Need for:

- Farming systems and methods designed to overcome these conflicts
- social and political solutions

Different approaches

- Socio-political oriented solutions
- Technological solutions
  - system innovation
  - process integrated solutions
    integrated technology
  - end of pipe solutions
- Participatory innovation or progress

Ingredients for system innovation

- Hardware
- Software
- Orgware

Farming systems research

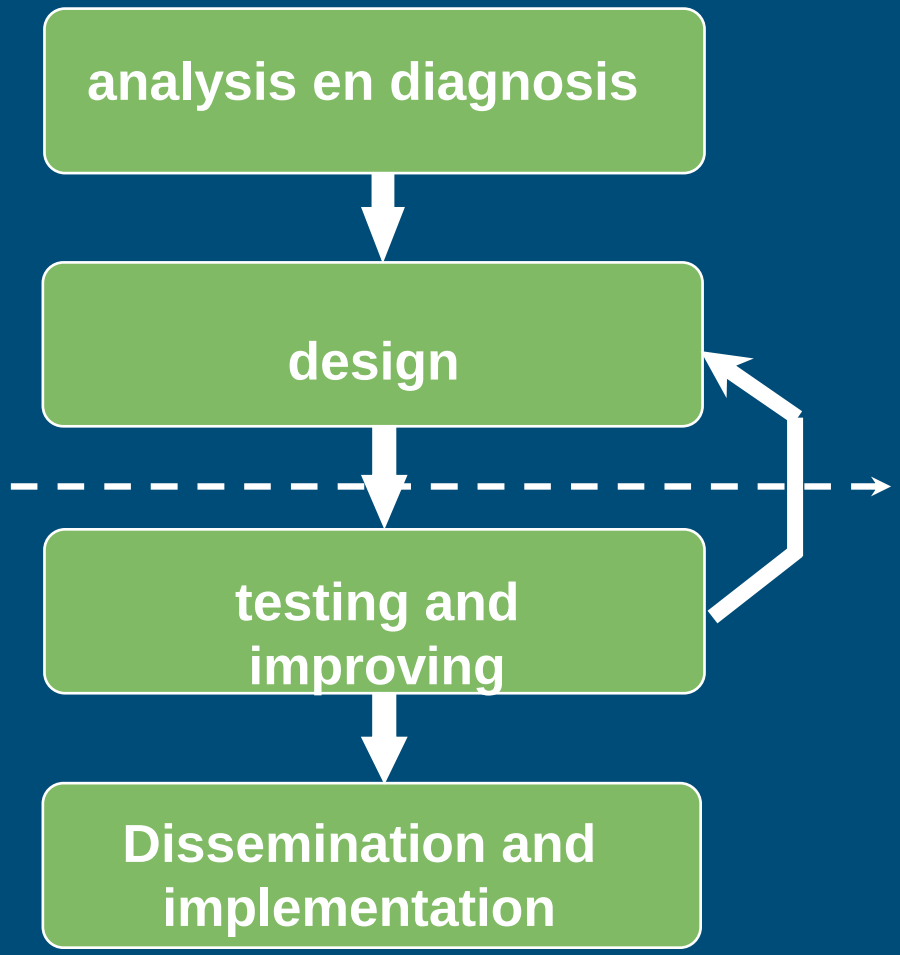
- System innovation: coherent overall concept, multi-objective
  - Agronomical
  - Ecological
  - Economical
- Integrated technology
  - agro-ecological principles, agronomy and technology Whole farm

Main search directions

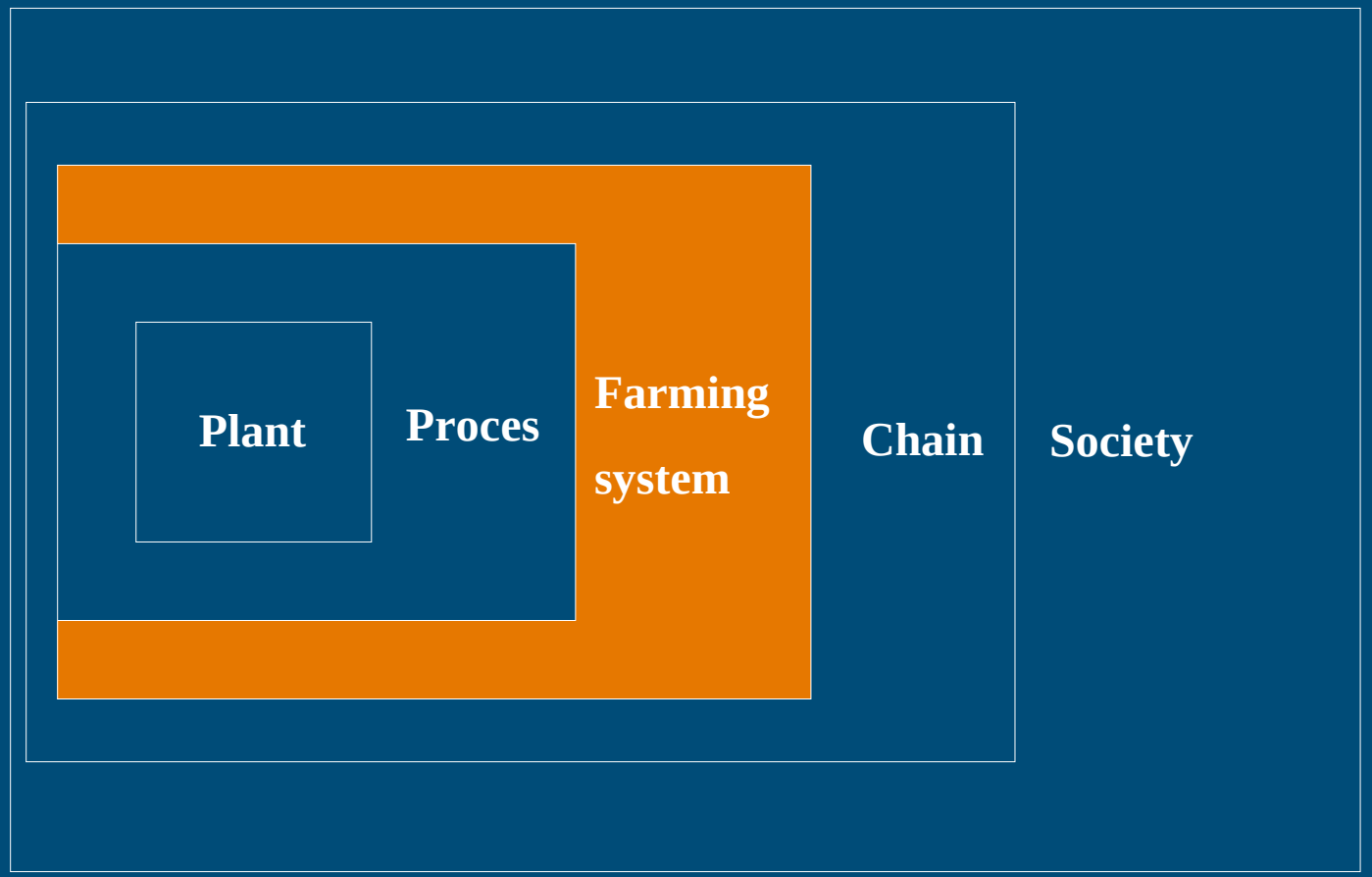
- integrated production
- organic production

Methodology: prototyping

- Methodical way to innovation from a technological perspective
- System level - system innovation



Systeem innovation



Prototyping (Vereijken)

- Analysis en Diagnosis
- Design
- Testing and Improving
- Dissemination and implementation

Analysis and diagnosis

- Regional farmstructure
- Constraints
- Policy and regulations
- Future developments

Design

- Establish objectives
  - Measure them with Yardsticks (parameters) and
  - Quantify them with target values
- Design farming methods
- Design operational plan

Your objectives

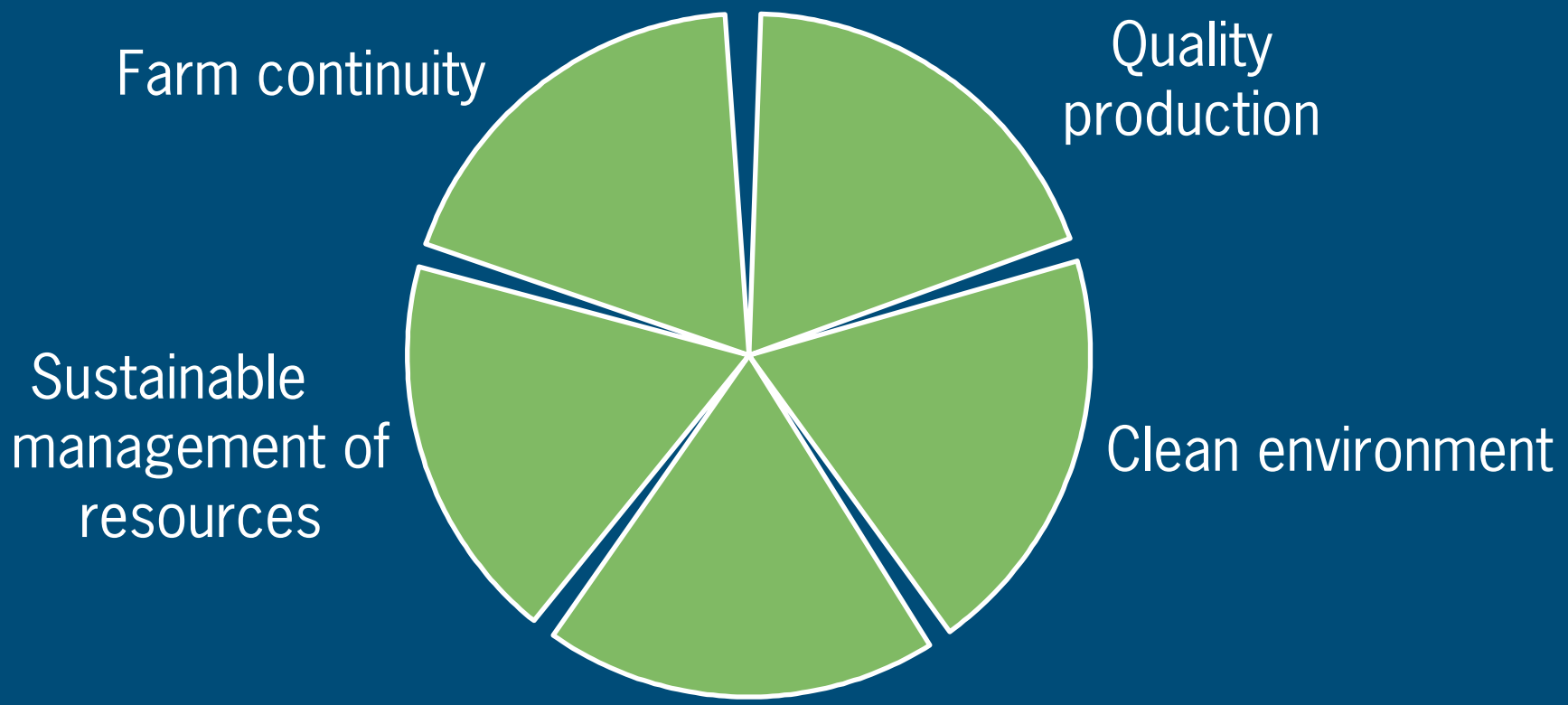
Write down at least 4 general objectives
In order of importance

(People, Planet, Profit)

Design: Objectives

- Abiotic environment
- Food Supply
- Nature and Landscape
- Basic income/profit
- Health well-being
- Integrity of life
- Employment
- Others??

Design: Thematic approach



Quantifying objectives

Write down 2 parameters(indicators) per PPP-theme

Try to define a target value per parameter

Design: Themes and parameters

- Farm continuity
  - Net profit
  - labour input (specified topics)
- Quality production
  - quantity and quality of produce
- Multifunctionality (in relation to on farm nature)
  - no of target species, no of target biotopes
  - infrastructure, area, connectivity, circuitry

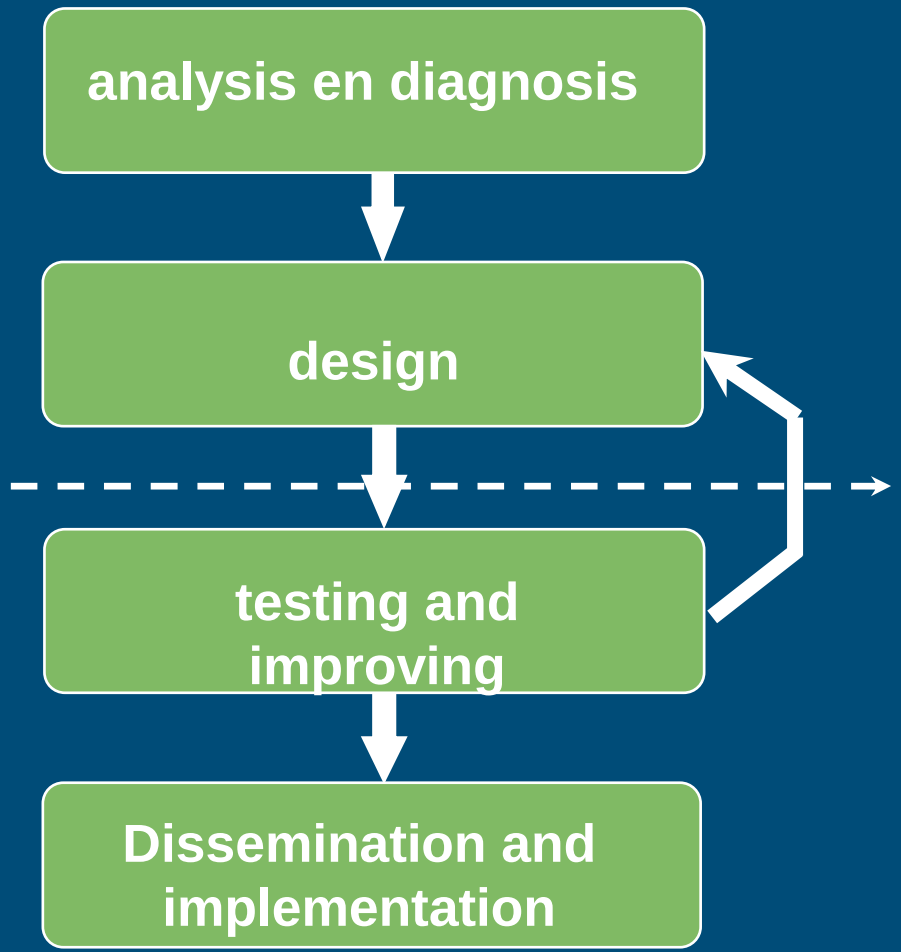
Design: Themes and parameters

- Sustainable use of resources
  - use of (fossil) energy and mineral P and K
  - soil fertility, soil cover, soil health
- Clean environment
  - use, emission and damage risk pesticides
  - use, surplus and emission nutrients
  - gas emissions

Design, testing and Improving : Farming methods

Agronomic Toolbox to realise values

- Crop rotation
- Soil cultivation
- Fertilisation/Nutrient management
- Crop protection
- On farm nature (biodiversity) management


analysis en diagnosis
design
testing and improving
Dissemination and implementation

Prototyping, testing and improving

Test:

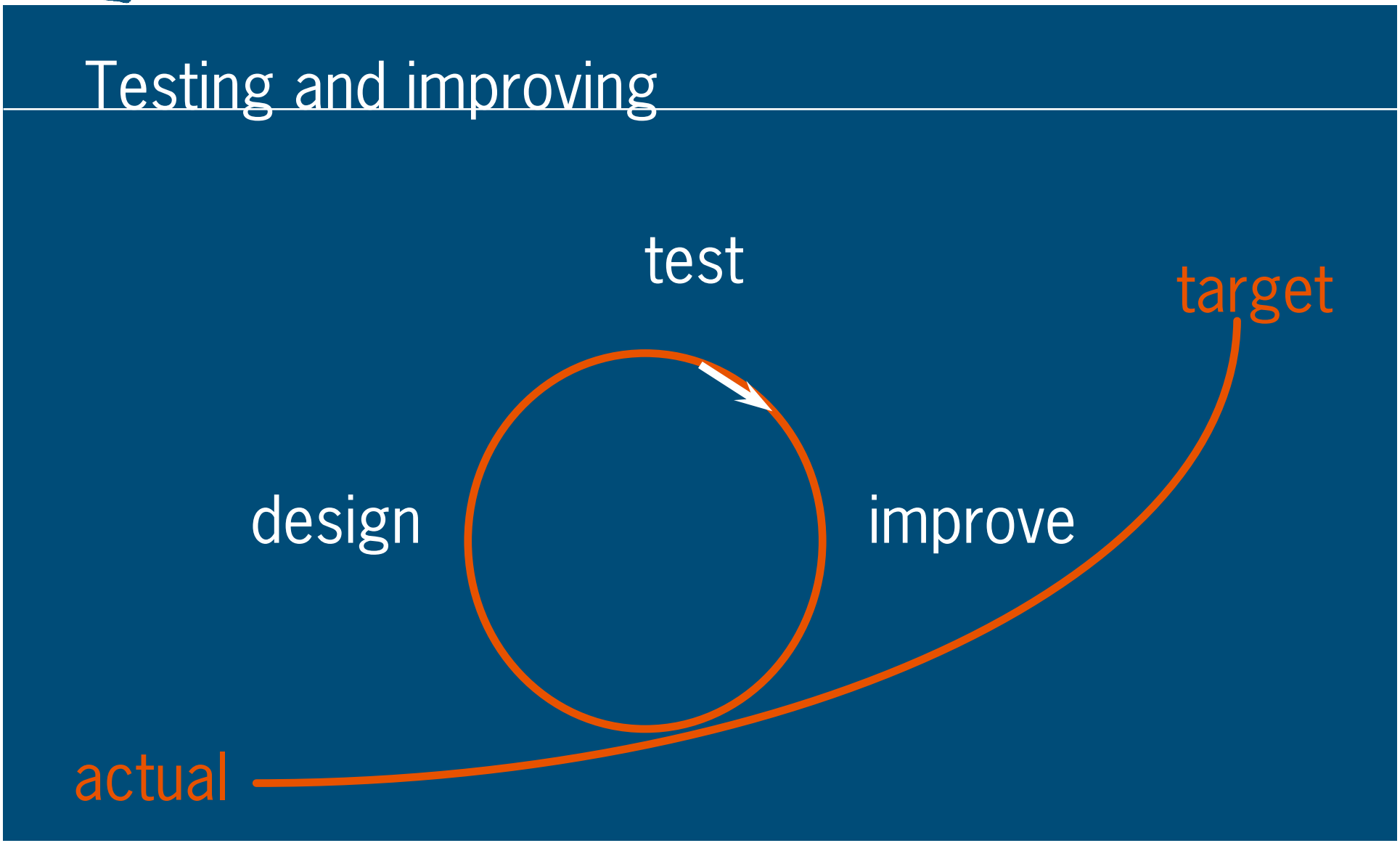
- lay out of prototype in practice
- measure results
- establish shortfall between target and result
- analyse cause in relation with methods

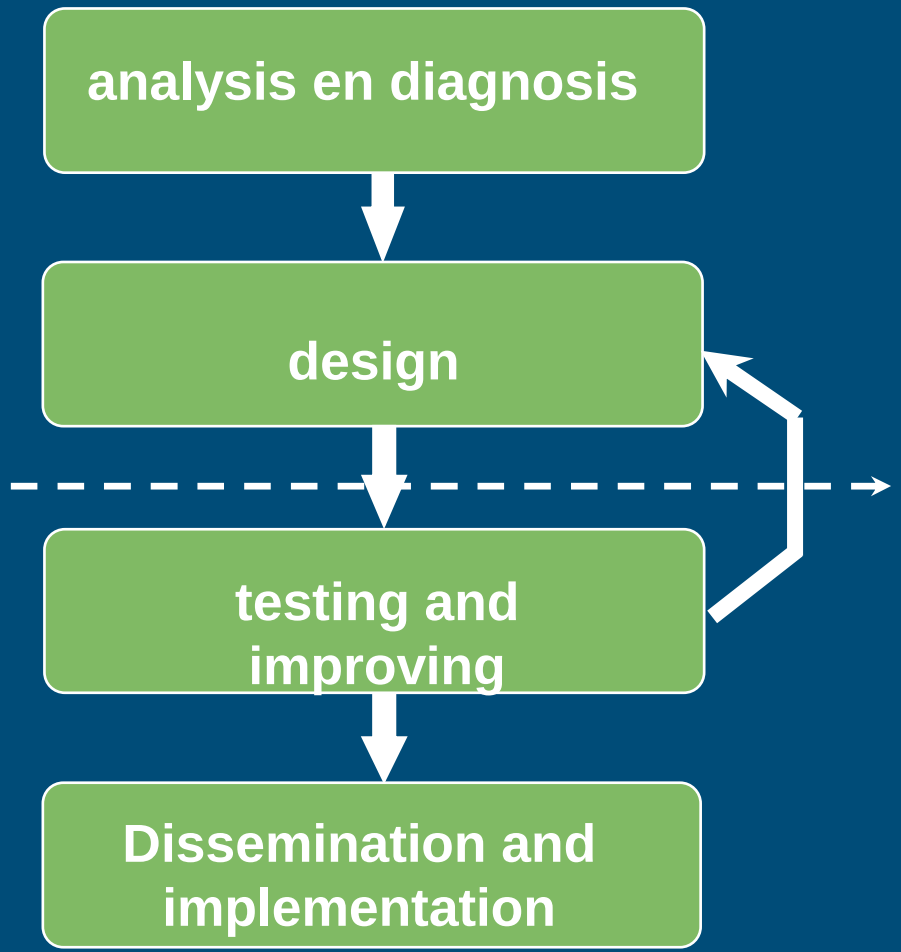
Improve

- focussed adjustment of farming methods

untill target results have been achieved

Testing and improving

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Dissemination and implementation

Prototyping, dissemination and implementation

- Coöperation
  - research, extension and practice
- Testing and improving systems in practice
  - manage ability
  - acceptability
- Demonstration
- Participatory learning
  - farmer field schools, study groups

Results prototyping

- Potential performance in terms of yardsticks
  - Legislation, certification
- Set of farming methods
  - Certification, advice, best practices
- Insight in bottlenecks and processes
- Remaining need for socio-opolitical solutions

Farming methods

- General strategy (concept)
- Toolbox of methods and techniques
- Flexible integration into approach
- Region and farm specific interpretation of these strategies

- Objective: excellent agronomy

Emphasis in farming methods

conventional *organic*

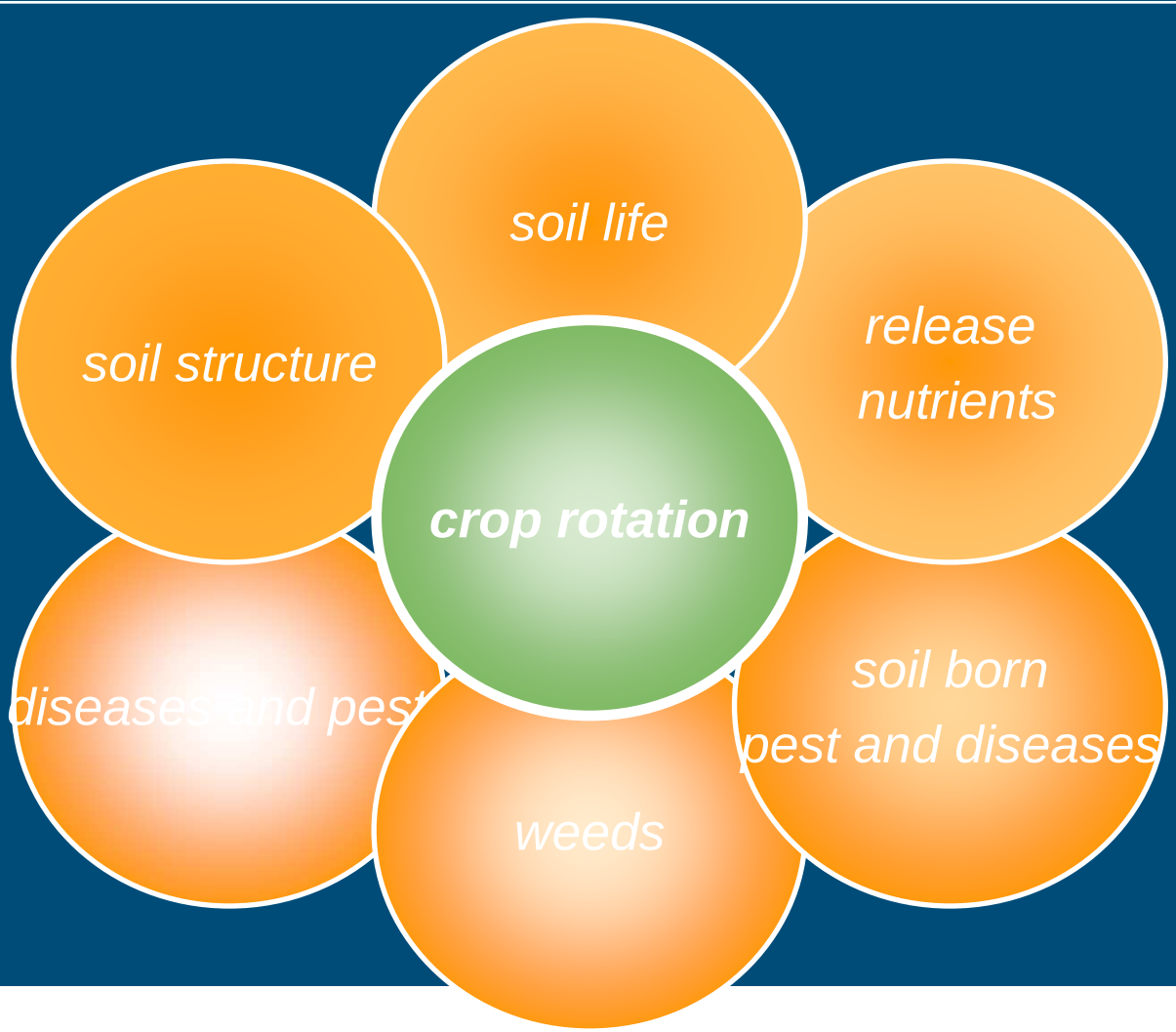
soil structure
- crop rotation
- organic manure
- green manure
- soil cultivation

nutrient supply
- crop rotation
- organic manure
- green manure
- mineral fertiliser

weeds
- crop rotation
- cropping system
- mech. control
- pesticides

pests and diseases
- crop rotation
- cropping system/ resistant varieties
- pesticides

Influence crop rotation



Multifunctional crop rotation

- basis for quality production

  supported by:
  - cropping systems
  - crop protection
  - on farm nature management and farm design
  - fertilisation
  - soil cultivation

- crop rotation is a team of players

Crop rotation

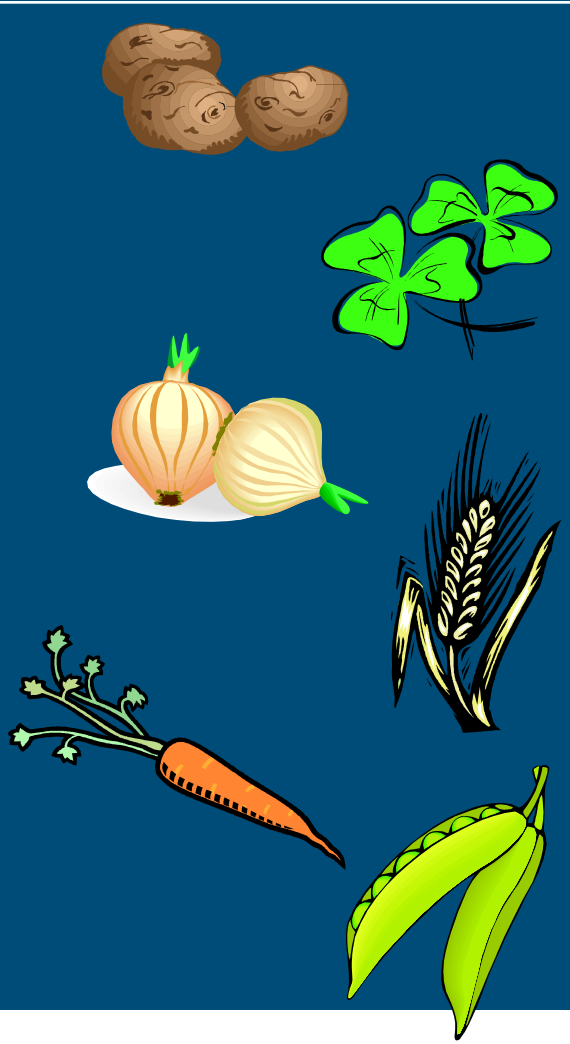
- Crop choice (team of players)
- Crop frequency
- Crop sequence
- Spatial layout

Balanced Crop choice

- High and low nutrient demand
- Nitrogen fixating crops
- Intensive and superficial rooting
- High and low weed suppression
- High and low labour demand
- Different species and families

Crop Rotation Example

1. Potatoes
2. Grass/clover
3. Onions
4. Springwheat
5. Carrots
6. Peas



Crop frequency, general recommendations

effective for crop specific soil born pests and diseases

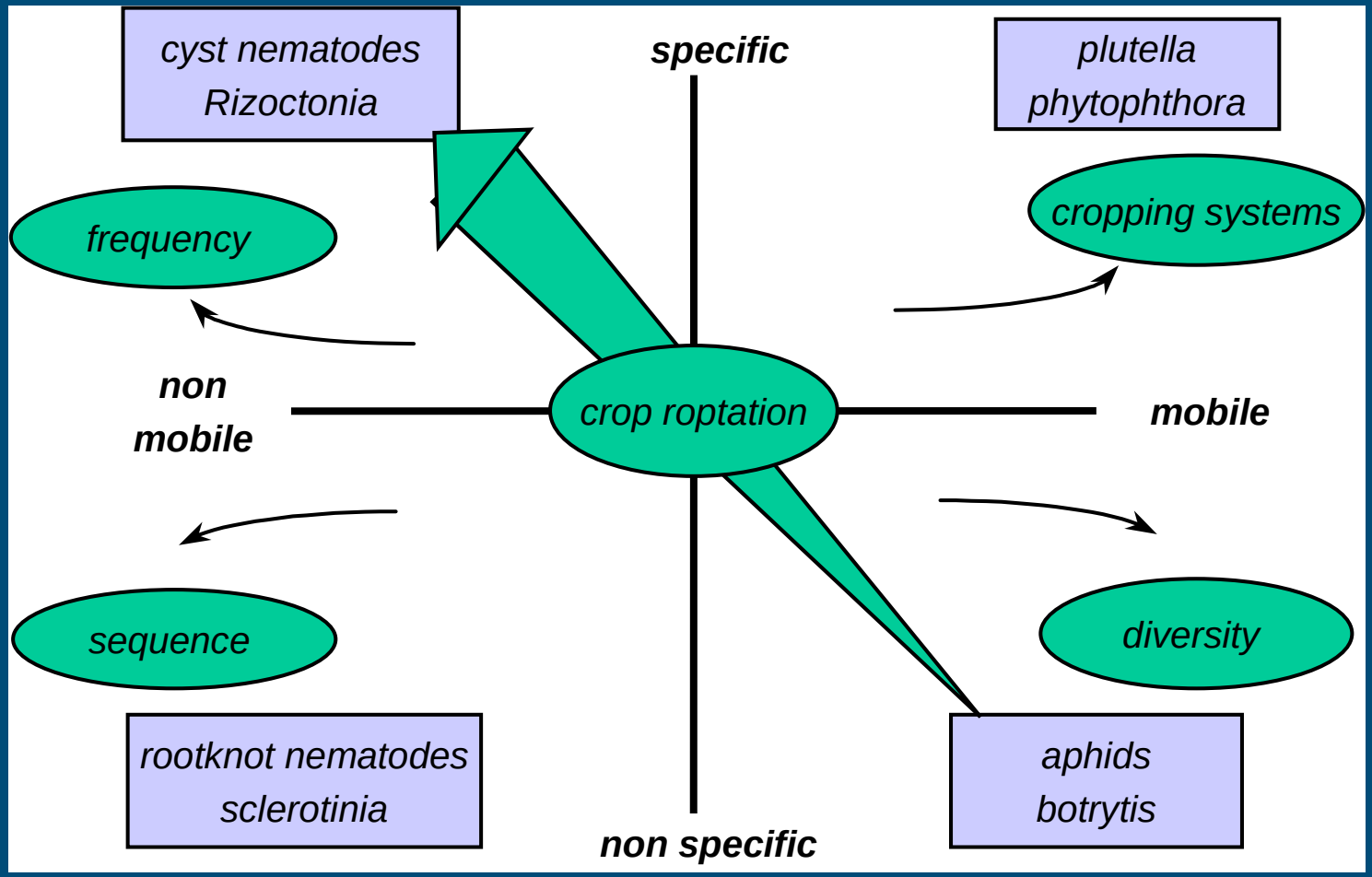
- 1 in 6 for species
- 1 in 3 for families

- Take also green manures into account

Crop sequence

- Soil structure
- Pests and Diseases
- Weed control

Crop Rotation, prevention of pests and diseases



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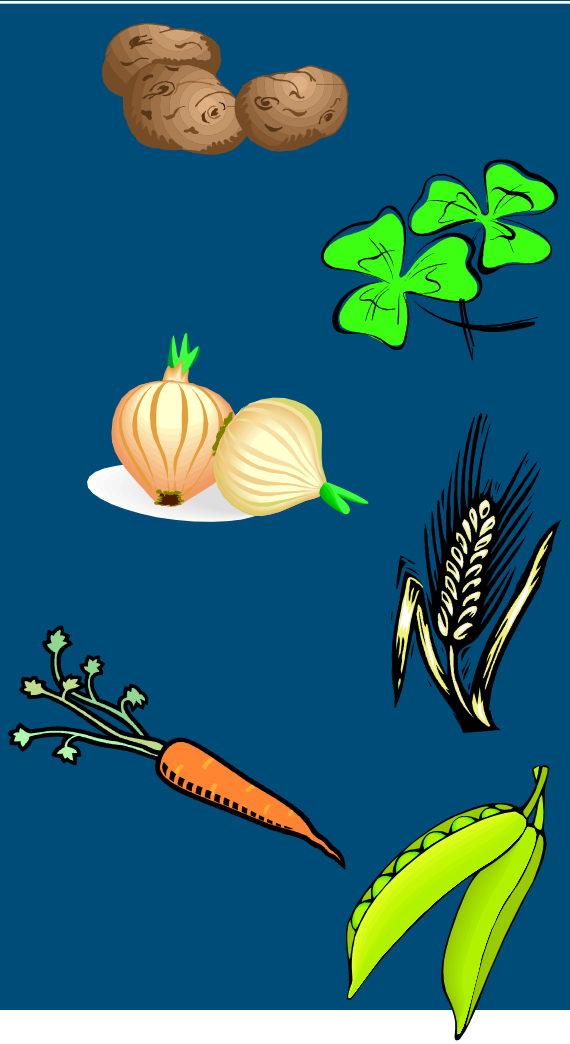
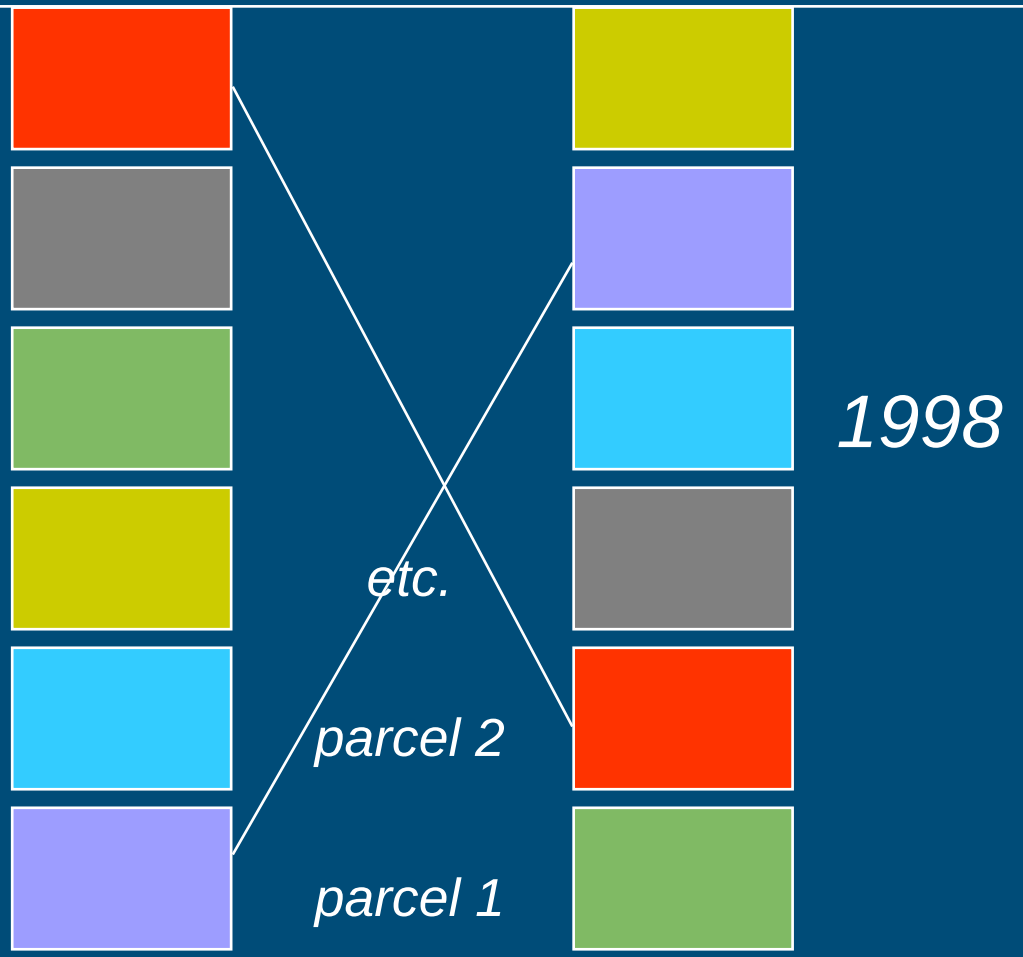


Spatial crop rotation

Supports prevention of semi mobile, specific organisms as cabbage fly



Strategy crop protection

- Prevention
  - crop rotation, farm hygiene,...
- Need of control
  - asses if control is necessary
- Control
  - non-chemical control (mechanical, biological)
  - chemical,
    - pesticide selection
    - application technique

Prevention

- **Prevention of initial inoculum**:
  - • legal measures,
  - • farm hygiene and healthy seeds and plant material.
- **Enhancing (bio) diversity:**
  - • crop rotation and variety choice,
  - • design of the agro-ecological layout,
  - • other means of bio-diversification.
- **Creating unfavourable conditions for noxious organisms**:
  - • cultural methods,
  - • nutrient management.

Establishing need of control

- determine if organisms are harmful,
- monitor,
- prognosis of infestation or infection,
- prognosis of economic loss.

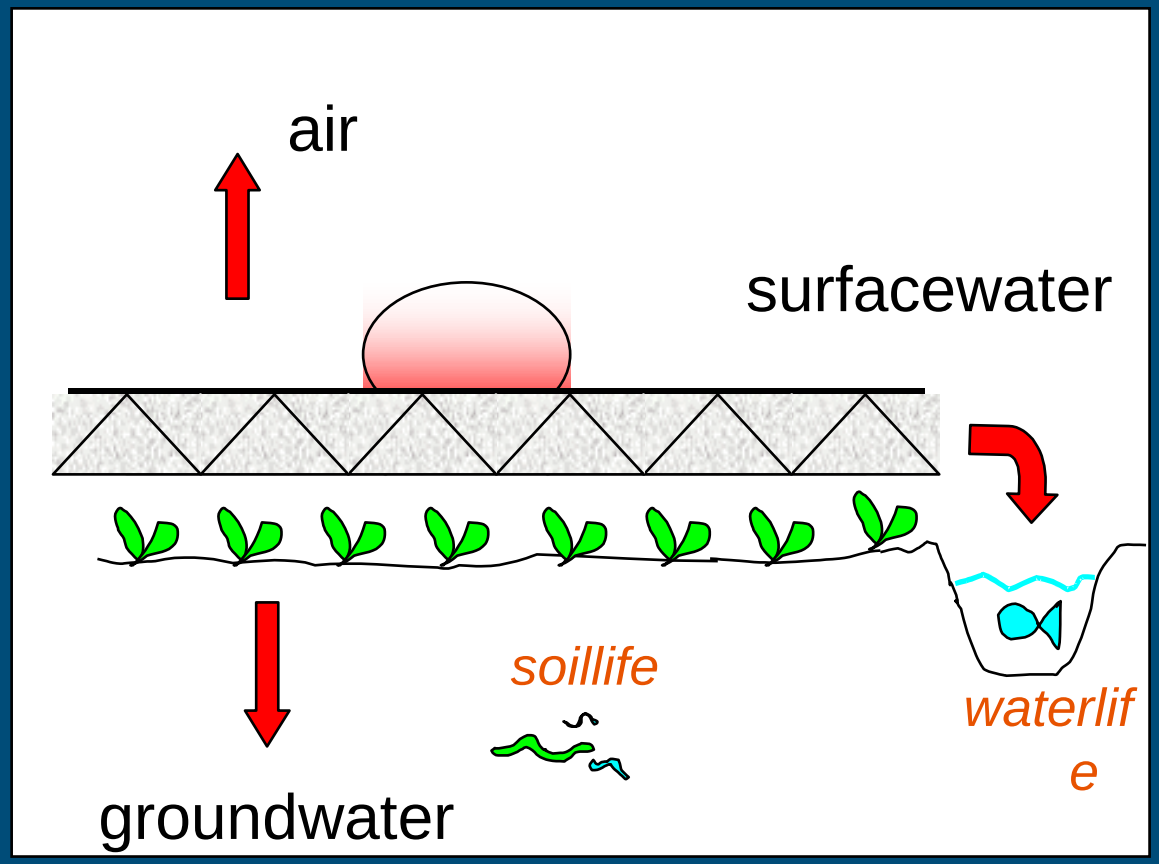
Control

- Physical
- Biological
- Chemical
  - pesticide choice
  - dose, timing and technique

Chemical control

- Choice of pesticides
  - selectivity
  - resistance development
  - emission and damage risks
- Application
  - timing, weather conditions
  - application technique
  - dose

Environmental effects pesticides



parameters

use

emission

damage

Nutrient management

Principles:

- maintenance of soil fertility in agronomic desired and ecologically acceptable range
- input = oftake + unavoidable losses for P and K
- nutrient losses < target values (EU norm)

APPLIED PLANT RESEARCH

PPO farming systems research

WAGENINGEN UR

PPO farming system research

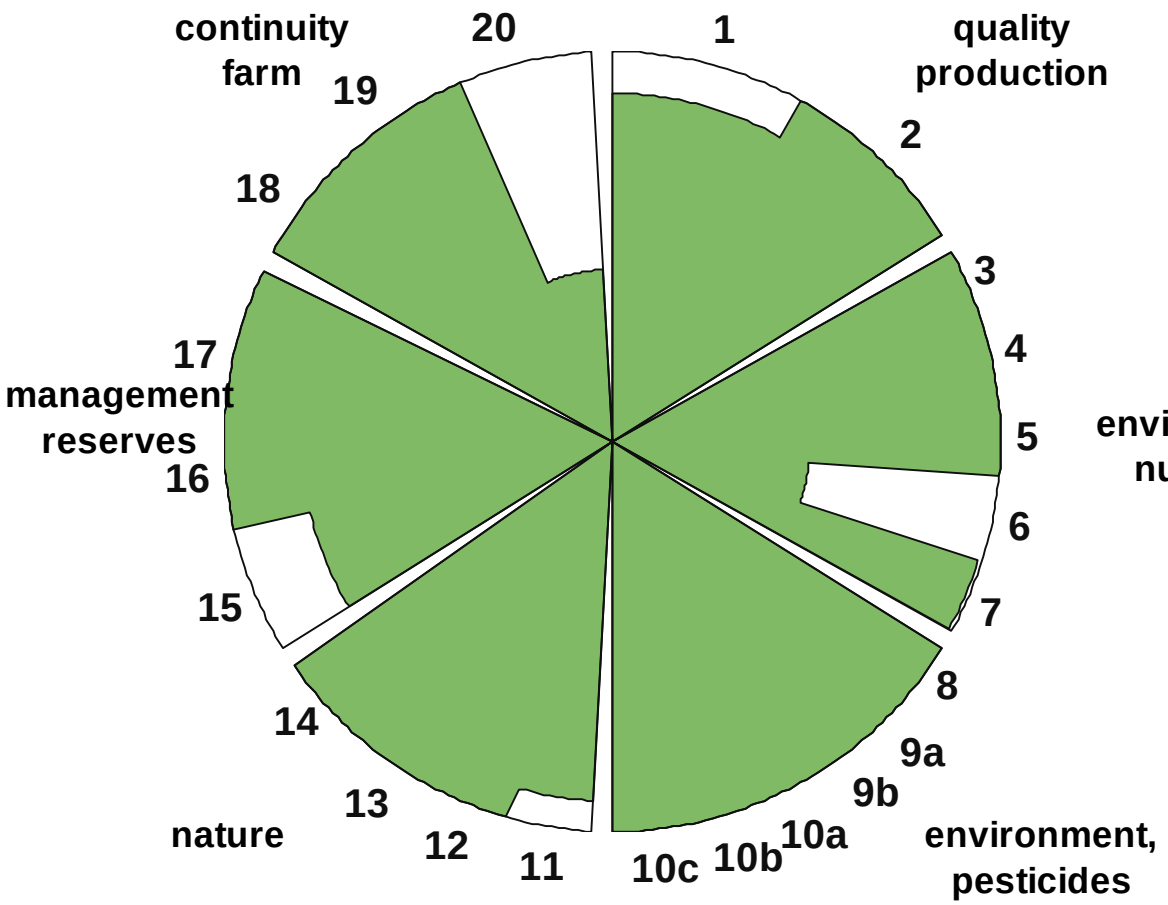
- (semi) practical scale
- no replications
- development path towards ‘all round’ farm
- until 1985 comparison conventional-integrated-organic
- later comparison with targets and average practice
- combination with pilot farm networks

Locations in the Netherlands (2003)

- Experimental locations
- Pilot farms organic
- Pilot farms integrated

Results

- Performance in terms of yardsticks
- Set of farming methods



1. quantity
2. quality
3. N leaching
4. N min November
5. N surplus
6. K surplus
7. P surplus
8. use active ingredient
9. Ecological Damage Index
10. Environment Exposure to Pesti
11. plant species diversity
12. plant species distribution
13. flower density
14. % ecological infrastructure
15. P soil reserves
16. K soil reserves
17. organic matter balance
18. net surplus
19. utilisation available labour
20. hours hand weeding

Results clean environment pesticides 2001

Experimental locations

Parameter	Target value	OBS	Westmaas	Meterik
EEP-air	< 0.7 kg/ha	0.3	0.6	0.4
EYP-water life	0% app. > 10 points	0	72	0
EEP-ground water	< 0.50 ppb	0.15	0.22	0.3
EEP-soil	< 200 kg days/ha	101	193	284
EYP-soil life	0% app. > 100 points	0	9	9
Active ingredients	kg/ha	1.5	2.1	3.8

Percentage reduction pesticides

(OBS 1978-2000)

Yardstick	Percentage reduction
emission air	92
damage waterlife	99
emission groundwater	99
emission soil	83
damage soillife	81
active ingredient input	95

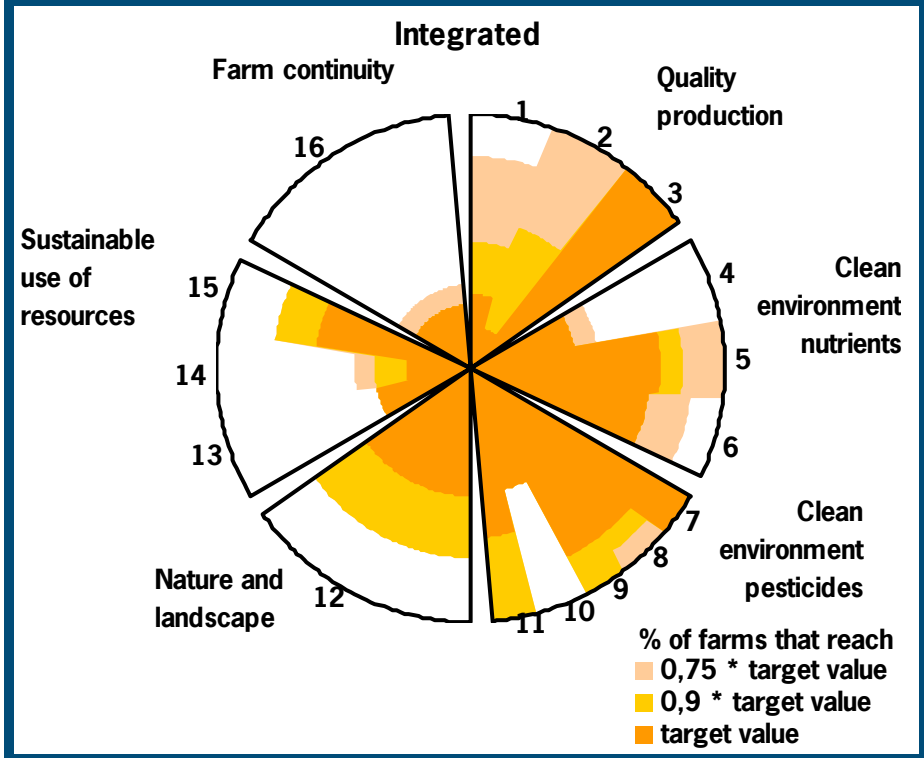
Results clean environment pesticides 2001

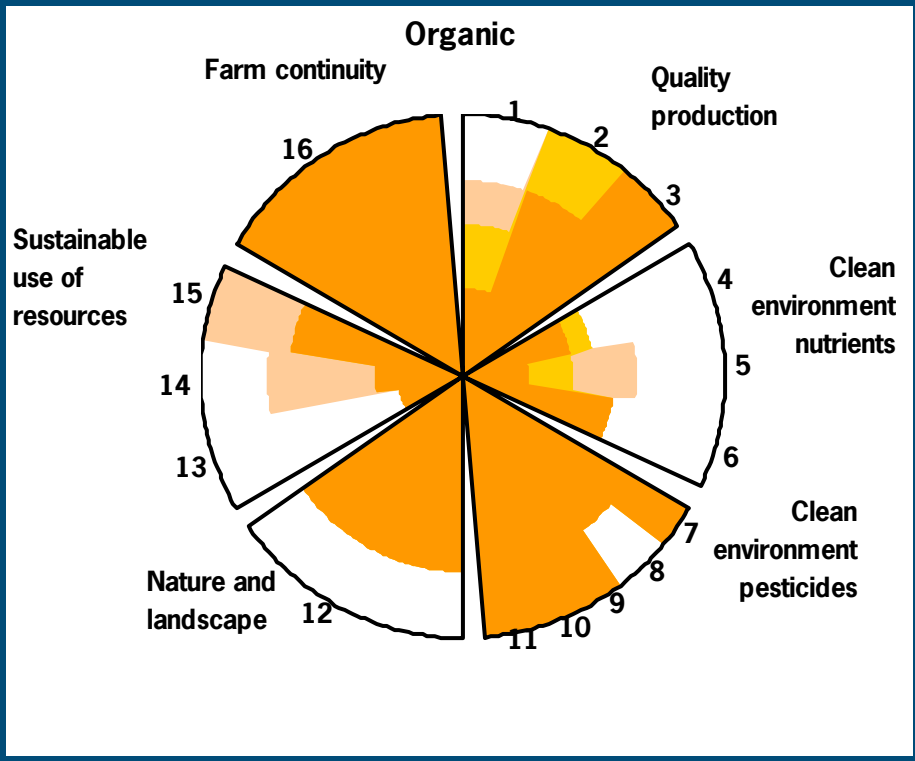
Pilot farms, vegetable farming

		Brabant		Limburg	
		97-99	2001	99-97	2001
EEP-air	< 0.7 kg/ha	2.1	1.2	1.0	0.4
EYP-water life	0% app. > 10 points		26		38
EEP-ground water	< 0.50 ppb	30.3	1.7	3.7	1.5
EEP-soil	< 200 kg days/ha	1646	653	681	340
EYP-soil life	0% app. > 100 points		7		29
Active ingredients	kg/ha	16.4	8.2	4.4	2.9

Comparison between integrated and organic systems

EU project Vegineco 1997-2002 (experimental farms)





Potential Organic farming

- Multifunctionality (production, recreation, care, nature and landscape)
- Sustainable and environment friendly
- Food safety (pesticide residues, allergies)
- Consumers preference (natural, healthy and tastefull)
- Biodiversity
- Employment
- Low input costs